Volume 3 / 2022

PATHWAYS

University of Saskatchewan

Archaeology and Anthropology Graduate Student Journal

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VOLUME 3

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Pathways, University of Saskatchewan Archaeology and Anthropology Graduate Student Journal is run by the UofS Department Archaeology and Archaeology Graduate Students' Association (ARCHAIA) and provides a medium by which to activate the conversations that we graduate students have within our classes to showcase the admirable work that is being done throughout our department. We also aim to provide opportunities for professional development to better prepare our graduates for futures in academia or in the professional realm. We promote original research, review articles, book reviews, high-reaching class papers, commentaries, plain writing summaries of theses, photo essays, and other multimedia submissions from graduate or senior undergraduate students. These works will focus on the four fields of anthropology and contribute to ongoing conversations of scholarship and collaboration. We welcome submissions from students studying at the University of Saskatchewan and beyond.

Produced by the University of Saskatchewan Archaeology and Anthropology Graduate Students' Association (ARCHAIA) and associated with the University of Saskatchewan Department of Archeology and Anthropology.

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Cover photo taken by Jessica Jack and depicts the University of Saskatchewan campus as seen from the front door of the Archaeology building.

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Pathways Editorial Board

Letter From the Editors-in-Chief

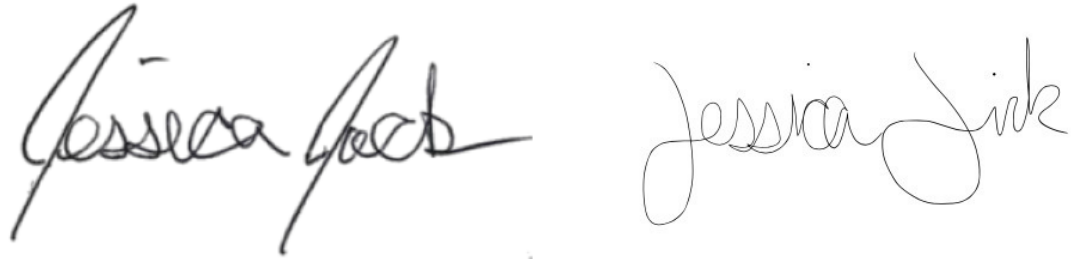
Dear Readers and Contributors,

It is with sincere pleasure that we introduce the third volume of Pathways, presented by ARCHAIA, the University of Saskatchewan Archaeology and Anthropology Graduate Students Association. As our young journal continues to establish itself through the efforts of previous editors Rachel Simpson, Rebecca Bourgeois, and Michelle Gowan, we strive to ensure that Pathways remains a platform through which the works of students in human studies are developed and shared. As we navigate through the ongoing COVID-19 pandemic and return to many in-person encounters, this journal continues to foster discourse on the human experience and the broader social sciences and humanities that study it. We are grateful for the enthusiastic effort and dedication of the editorial board and the contributing authors as we continue to deal with the challenges of ongoing reconciliation, global climate change, and broad political unrest.

In these pages, we continue to make Pathways a space for thoughtful engagement and fresh exploration of topics through articles written by excellent students, voicing their thoughts and experiencing the publication process. This third volume highlights contributions from both undergraduate and graduate students from the University of Saskatchewan, as well as editorial members from the University of Alberta, Queen's University, and Lakehead University. These fabulous pieces cover a range of subjects, including gender-critical history, medical anthropology, public archaeology, queer anthropology, and zooarchaeology. In finding our feet as a journal, we continue to explore new perspectives and, in this volume, some new types of articles. For the first time, this volume features a commentary article, as well as continued fantastic scholarship in research and review articles, thus making space for many types of student voices to be heard.

This journal continues to be a group effort, and so many people are necessary to its production and publication. We owe many debts of gratitude for input, help, and patience. To the ARCHAIA executive committee, and the U of S Department of Archaeology and Anthropology, we continue to offer our deepest thanks for their guidance and enthusiasm for this project. Our fellow journal, the team at the USURJ, and Liv Marken have continued to be incredibly helpful and supportive. Thanks to the University of Alberta Libraries Journal Hosting and Publishing, with special thanks to Sonya Betz and Sarah Severson, who handle the distribution and accessibility of this journal. Last, and possibly most, our warmest thanks to our fantastic team of reviewers, our copy editor Mckelvey Kelly, and our faculty advisors Dr. Susanna Barnes, and Dr. Angela Lieverse. These people have put hours of focus, thought, and effort into crafting this volume into the work you see before you. Through their efforts, we present you with the third volume of Pathways, a window into the perspectives and ideas of students of the human
Sincerely,

Jessica Jack and Jessica Sick
Co-Editors-in-Chief



Correction

We are issuing a correction for the author list for an article published in Pathways Volume 2 in October of 2021. The article titled “Assessing Impacts of the COVID-19 Pandemic on Anthropological Research Methods: An Undergraduate Research Project” was listed as having been published by Sean Dempsey, Bailey Holloway, Kyra Chambers, Shannon Hecker, Ming Draper, Julia Gallant, Jag Kang, Trevor Lamb, Marlee Stewart, and Tara Joly.

The correct author list for this article is instead: Sean Dempsey, **Tom Haiworonsky**, Bailey Holloway, Kyra Chambers, Shannon Hecker, Ming Draper, Julia Gallant, Jag Kang, Trevor Lamb, Marlee Stewart, and Tara Joly.

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COMMENTARY ARTICLE

A Pathway to Reconciliation within 'North American' Archaeology

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Editor's Note:
This article originated as a blog post and is meant to be an accessible, casual discussion of a serious topic. Pathways Journal is committed to representing academic voices on human studies in a variety of styles and topics, including this condensed approach to commentary. For further discussion on some of the topics raised in this commentary, see Fender's article "Addressing the Alien in the Room: Why Public Perception is Imperative to the Field of Archaeology" on page 29 of this volume.

Abstract:
As we begin to enter an era of reconciliation in archaeology, we must look at the foundation upon which the discipline has been built and start to dismantle the colonial ideologies which have been embedded within. A number of new practices and approaches have emerged over the past decade, through community and public based archaeology, placing the community at the forefront of the research. These newer approaches have set out to challenge the ways in which the discipline had been conducted previously, creating pathways forward for reconciliation. The following commentary is based on my experience as a student researcher and professional archaeologist over the past six years ─ experience which has been shaped by my identity and the lens it informs and which offers only one perspective towards the important and emerging narrative on reconciliation within archaeology.

Before I begin, I would like to acknowledge my positionality as a researcher. I am a Canadian archaeologist of Euro-settler descent and do not come from the communities in which I carry out my research and subsequent projects. The following commentary is based on my experience as a student researcher and professional archaeologist over the past six years, experience which has been shaped by my identity and the lens it informs and which offers only one perspective towards the important and emerging narrative on reconciliation within archaeology.

"Whom and what does your research help?"

This is one of the first questions my would-be supervisor asked me when I wanted to enter graduate school to complete a Master of Arts degree in Archaeology. At the time, I remember thinking how a question, so seemingly simple, could be so daunting.

How could my research help the living community?

How could I ensure that my work would have impact beyond me, beyond just checking off boxes to complete a degree?

'North American' archaeology or 'American' archaeology focuses on Indigenous human occupation, spanning tens

of thousands of years[1], across the continent of North America. The discipline of archaeology—and its academic institutional origins—has a dark past, one rooted deeply in European colonialism. Colonialism, brought forth by European explorers, was used to justify the oppression of non-European societies through social, political, and economic control. Early within the discipline, archaeologists and anthropologists[2] began to explore these newly colonized areas, conducting research by spending long periods of time with the people of these regions. This engagement would become the precursor for participant observation, a method through which researchers actively participate in community activities to gain a deeper understanding of the internal structures of their society or culture[3].

However, due to the colonial European ideologies predominant during this time, these encounters were typically rooted in Eurocentric[4] and race-based theories and methods. Many of the ideas about culture were inspired by naturalist Charles Darwin's theory of natural selection. These frameworks were informed by the idea of unilineal evolution, a social theory suggesting that all human groups evolve in stages. Unilineal evolution categorized human groups based on a linear idea of social progress, ranging from "simple" to "complex" based on a variety of criterion.

Unfortunately, these explorations came at a cost: not to those conducting the research, but at the expense of those being researched.

It was during this time that salvage anthropology was born, and the rush began to document these communities as much as possible before they disappeared or "evolved" due to their exposure to "advanced" European ways. However, these "advanced" European ways brought new obstacles to Indigenous groups across North America, including exposure to new diseases, forced assimilation, genocide, conflict, and more. These lasting negative impacts of European immigration and eventual colonization of the continent decimated Indigenous populations, contributing to the scramble to document these communities before they were gone. This race to document, preserve, and "save" these communities ironically contributed to the disruption of knowledge transmission and the loss of cultural traditions through the taking of cultural materials, both tangible and intangible (i.e., tangible cultural belongings and intangible oral histories and knowledge).

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[1] This is a rough estimate based on archaeological data, which is still highly contested, and likely to change with the uncovering of new archaeological sites indefinitely. Oral histories from Indigenous communities indicate occupation of North America since time immemorial.

[2] Anthropology, or the study of humanity, comprises biological anthropology, sociocultural anthropology, linguistic anthropology, and archaeology. Archaeology and anthropology are included here to denote the study of both the human past and the human present.

[3] Early on within the field of anthropology, researchers could conduct studies and make conclusions on communities or cultures without ever having been in contact with them. This type of research, later called *armchair anthropology*, was quickly rejected by scholars as serious problems arose from this approach, such as the production of inaccuracies and biased claims. After this short-lived attempt, the idea that the researcher should spend time with and in the communities they sought to understand rose to the forefront of the discipline and paved the path for what anthropology is today. Following this time period, Bronislaw Malinowski, an anthropologist during the early 1900s, developed participant observation while conducting fieldwork to approach the study of cultures in a more human way, where the researcher actively participated in the community. See more at https://perspectives.pressbooks.com/chapter/doing-fieldwork-methods-in-cultural-anthropology/

[4] Eurocentric is defined as "reflecting a tendency to interpret the world in terms of European or Anglo-American values and experiences" (see https://www.merriam-webster.com/dictionary/Eurocentric). Often these interpretations also were biased by ethnocentric views, which was "based on the attitude that one's own group is superior" (see https://www.merriam-webster.com/dictionary/ethnocentric).

Over time, with the continued resilience of Indigenous communities and revitalization of traditional practices, these European ideas of "evolution" were challenged and ultimately rejected, allowing for the more standardized and culturally relative study of cultures and societies to emerge. New requirements, such as formal training and peer-review, were developed to combat these early ideologies that were no longer accepted by the academic world. As a result, researchers began to be held accountable to maintain the relationships with the communities in which they worked, as well as honouring their obligations that were agreed upon throughout the extent of the research being conducted, which many had failed to do early on within the discipline.

Although the discipline has and continues to change—as all human cultural things do—remnants of these colonial ideologies remain, embedded within the foundation upon which archaeology was built. In light of this acknowledgment, we are then faced with another question; how do we, as emerging researchers, as the beneficiaries of these established disciplines, change a system from within?

As an undergraduate student, I had many interests with little certainty about what specific field I wanted to study. I blindly went into an elective first year archaeology course, curious about the history of the human past and intrigued by adventures of the fictitious, yet infamous, Indiana Jones[5] dancing around my head. Today—eight years later—here I am, almost finished with my master's degree in archaeology and, along with never fully committing to the fedora, I am much less destructive (e.g., no temple ransacking) and will wager that I take vastly better field notes than our whip-snapping, boobytrap-dodging heartthrob.

But even still, my curiosity and passion for the past has not dimmed but brightened. And while I had initially planned to pursue my graduate studies conducting archaeological research within Europe, a summer field school on the Northwest Coast of North America changed all these plans. All because of one word: "Community."

Community archaeology is distinctive in that the living descendants or communities are actively involved in the research process (to whatever extent or capacity that they wish to be). From initial planning to sharing results both within the community and to the broader public (according to community wishes), this approach to research uses multiple perspectives to connect the past to the present.

This newer approach challenges the ways in which archaeology had been conducted for so many decades before, creating paths for collaboration and connection under a new framework with the same communities that lost so much at the hands of the same discipline. This integrated relationship ensures that the mistakes of our discipline's past are not repeated, placing the community at the forefront of the research, making sure that their needs are not only met but are also not superseded by institutional demands.

A researcher's obligations to both the community and institution are sometimes difficult to balance. This balancing act becomes increasingly challenging due to restrictions on resources, funds, and time. However, accepting these complex (and at times conflicting) responsibilities is necessary if we are to reinvent the foundations on which archaeological research is conducted within North America.

How community archaeology looks in terms of 'boots on the ground' is entirely dependent on the project and the level of

[5] Dr. Henry Walton 'Indiana' Jones, Jr., a professor of archaeology (fictional), was made famous through his adventures of saving artifacts and punching Nazis throughout several movies (beginning in 1981). Although through these escapades, he arguably destroyed more material culture than he saved, his impact on the image of archaeology will last forever.

collaboration. To me, it involved site visits, community-days, ceremonies, interviews, youth programs, and more—events made possible due to a relationship built on mutual respect, cultivated over a decade of work by my graduate supervisor/predecessors, and maintained by ongoing reciprocity and partnership.

Public archaeology involves the inclusion of the public within the archaeological process. Although this may be different project to project, this methodology is based on active engagement and interest from the public (e.g., volunteer digs, field visits, research presentations, and more). By creating this interaction between the public and academic sphere, archaeology can become more accessible and meaningful. Instead of taking the information that researchers have gained from their studies and relaying this knowledge solely through articles locked behind paywalls or as brief presentations at expensive 'membership-access' conferences, archaeology can act as a pathway for communities to reconnect to their past, supporting their active involvement in telling the story of who they are.

Reconciliation, within this context, refers to the creation of positive and respectful relationships between Indigenous and non-Indigenous peoples within North America and beyond. This occurs through the understanding and acknowledgment of colonization and its effects on Indigenous populations, and the imperative movement away from the structures that are still upholding these ideologies today. With the creation of the United Nations Declaration on the Rights of Indigenous Peoples[6] and the Truth and Reconciliation Commission of Canada: Calls to Action[7] documents, we may begin developing new ways to steer away from these colonial beginnings, using these texts as our guiding principles. If we truly want to enter an era of reconciliation within archaeology, and mend our relationships to create positive, mutually beneficial collaborations, we must begin changing how we structure our research and projects to allow for open engagement, collaboration, and discussions. By practicing community archaeology, we, as researchers, must work with communities to understand what they want or need, to listen, to actively help, to support, and, through these efforts, to begin and continue to give back—back to those whose communities gave (or had taken away) so much.

[6] United Nations Declaration on the Rights of Indigenous Peoples https://www.un.org/development/desa/indigenouspeoples/wp-content/uploads/sites/19/2018/11/UNDRIP_E_web.pdf

[7] Truth and Reconciliation Commission of Canada: Calls to Action https://ehprnh2mwo3.exactdn.com/wp-content/uploads/2021/01/Calls_to_Action_English2.pdf

RESEARCH ARTICLE

Masculinity in Folklore: The Enduring Symbolism of the Canadian Lumberjack

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ABSTRACT

The nineteenth-century logging industry in North America produced working conditions that gave birth to many folk tales and folk heroes that have held firm, keeping the lumberjack a topic of popular culture that has endured for over a century. Through examining a historical painting and sketch inspired by the popular French-Canadian folktale La Chasse Galerie, present-day people can better understand the different historical influences, such as religion and ethnicity, that helped create folklore and ideas of masculinity within the timber trade in the Ottawa Valley. In addition, the masculinity that logging folk heroes and folk tales embody can help illustrate trends in modern resource extraction industries.

Keywords: working-class, masculinity, gender, storytelling, logging, historical popular culture

Even before the rise of the "lumbersexual" [1] aesthetic in North American pop culture in the mid-2010s, cultural conceptions of lumberjacks, like the artwork featured in Figures 2 and 3, were popular in the Ottawa Valley and throughout Canada. Even today, people do not have to think hard to conjure up imagery of lumberjacks: groups of rugged men working alone in the vast hinterlands, facing life-threatening danger, and exercising incredible strength, all while clad in classic red and black plaid. The lumberjack remains an important symbol of Canadian nation-building, industrial expansion, and taming of the

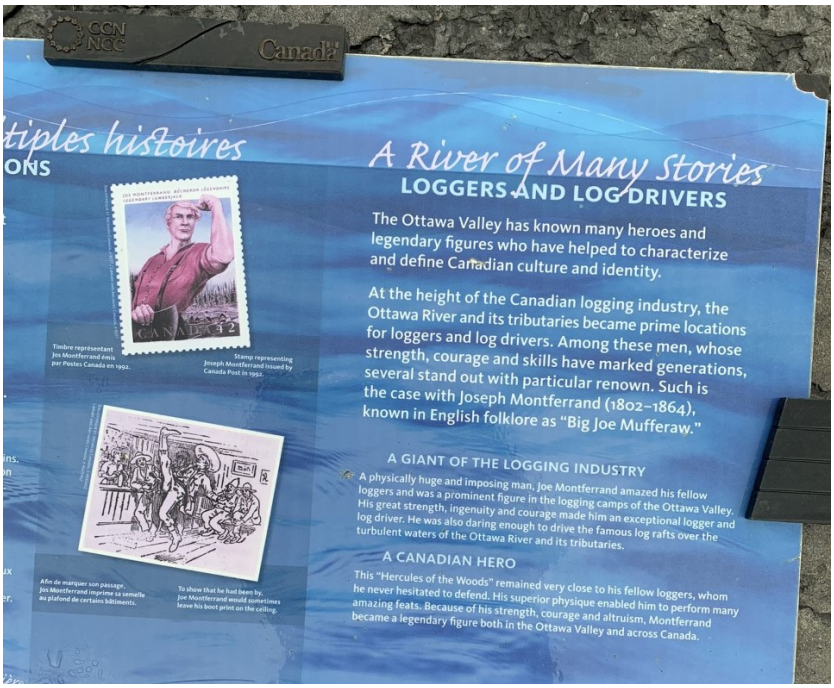

FIGURE 1–*A photo of a public plaque along the Ottawa River in Gatineau, QC., describing folk hero Joseph Montferrand. Photo taken by author.*

[1] A man whose style of dress and appearance is reminiscent of the ruggedly masculine stereotype of the lumberjack, as in wearing plaid shirts and having a beard (Lexico Online Dictionary n.d.).

wilderness (Lower 1938; Lower 1973). Within these isolated communities of labourers, loggers told tales of wild feats and daring logging adventures in the evenings to entertain, inspire, and act as cautionary tales, slowly evolving into folklore and entering the ethos of the North American public (Higgins 1935; Steward and Watt 1916; MacKay 2007).

Remnants of Canada's rich logging history and the masculine qualities of the Canadian lumberjack are evident in cultural elements and national narratives that are still relevant today. For example, lumberjack influence is evident in Canadian music, film, fashion, and folk heroes, such as Stompin' Tom Conners' song "The Canadian Lumberjack"; the National Film Board of Canada's Log Drivers' Waltz, a classic animated work that is still shown to Canadian school children today; in fashion, many Canadians embody a hipster, 'lumbersexual' style that invokes the idea of grit and outdoor know-how; and famous logging folk heroes, such as Paul Bunyan or Joseph Montferrand, are well known and continue to be culturally relevant. The contextual conditions in which men lived in early resource extraction industries, like the lumber industry, contributed to a specific representation of masculinity in early Canada. As a result of this widespread cultural creation of a masculine archetype, folktales and folk heroes who embodied that type of masculinity arose and became highly celebrated in Canadian culture. This masculinity continues to have ongoing implications for the modern resource extraction industries such as oil and gas, logging, and mining.

FIGURE 2– *La Chasse-Galerie (Julien 1906). Image of an oil painting on canvas.*

One of the first well-known folk heroes in eastern Canada who exemplified masculinity within the logging industry was Joseph "Jos" Montferrand, anglicized as Big Joe Mufferaw, a lumberjack who thrived in the logging industry in the early nineteenth century. He was a man of incredible strength and so tall he would leave a boot print on the eight-foot-tall ceilings of any tavern he visited to let others know he had been there (MacKay 2007, 35). His strength and daring character were legendary in the Ottawa Valley, and the tales about his daring exploits travelled far and wide throughout the continent. Lumberjacks told the epic stories of the timber beast Joseph Montferrand and his mythical white pet moose, spreading these stories across eastern Canada and the forty-ninth parallel into the USA in Michigan and Wisconsin (MacKay 2007, 38–39). The masculinity that Montferrand exemplified in the early nineteenth century laid the groundwork for aspirational lumberjack masculinity within the logging industry and the types of masculinity represented within folktales originating in lumber camps, such as the well-known story of La Chasse-Galerie. La Chasse-Galerie continues to be culturally relevant into the twenty-first century, with the most recent rendition of the folktale being a 2016 Quebecois film called Chasse-Galerie: La Légende. In the Ottawa Valley region, recognition of the importance that nineteenth-century logging, lumber barons, and folk heroes had to the area is still seen today in contemporary museums, films, folktales, stores, historical plaques, street names, and buildings.

The folktale of La Chasse Galerie was told in lumber camps long before Honoré Beaugrand wrote the best-known version of the folktale. First published in English in 1892 in a New York newspaper and later republished in 1900 in a collection of short stories called La Chasse Galerie and Other Canadian Stories, Beaugrand exposed a broad audience to stories created within logging camps and shanty men accounts (Beaugrand 1900, 9). Within the collection of short folktales Beaugrand wrote, Henri Julien provided sketches to enhance the stories. La Chasse-Galerie remained important to Julien. Six years after publishing his drawings (Fig. 3) in Beaugrand's collection of short stories, he created the oil painting (Figure 2) depicting the lumbermen’s encounter with danger high in the sky as the wispy and spectral appearance of the devil takes control of their birchbark canoe. Julien's artwork (Figures 2 and 3) showcases rugged masculinity as the men immortalized in oil paint and graphite look rough, tough, and buff. Additionally, similar to the one featured in Julien's artwork, the birchbark canoe is a popular Canadian motif that continues to be culturally important and relevant in the twenty-first century (Marsh 2006).

La Chasse Galerie tells the tale of a group of lumberjacks who long to partake in New Year's Eve celebrations. Desperate, they deal with the devil to gain a flying canoe. The agreement is made under the condition that there is no utterance of God's name nor touching of church steeples during travel. While the loggers originally planned to stay sober, the navigator did not and became belligerent with his words and actions, endangering the lives of his fellow loggers. This tale serves as a cautionary account of the dangers of impiety, excessive drinking, and using the Lord's name in vain. The folktale ends differently from version to version. Sometimes, the devil damns the loggers to fly the canoe through hell. In another version, after violently gagging the swearing navigator, the loggers crash the flying canoe and avoid the devil taking their souls. Regardless of how the story ends, each account depicts the lumberjacks as prone to violence, vice, and misdeed. They are characterized as miscreants. Christian beliefs are evident in the folktale’s descriptions of the actions of the loggers and the dangers of dealings with the devil. The influences of Christianity and Christian masculine ideals

from Irish, French, and English settlers are evident within this story, as Christianity was the dominant religion, with ninety percent of Canada's population belonging to a Christian sect until the early twentieth century (Bramadat and Seljak 2008, xii). Victorian stories and literature in the nineteenth century began to assert qualities of Christian Manliness, also known as Muscular Christianity, which prized hegemonic masculinity and qualities of independence, daring, bravery, fighting against blaspheme, resisting the consumption of liquor, creating a sense of community, and building spirit and muscles (Phillips 1995, 597–603; Roussel 2003, 146–149). The influence of Muscular Christianity in the nineteenth century had trickled into Canada by the early twentieth century, thus helping to shape the discourse around manhood further and revitalize what it meant to be a man in a religious context (Roussel 2003, 146–147).

The story and the artwork of La Chasse-Galerie highlight the dangers of impiety and how lack of glory to God can damn a logger straight to hell. Death and dismemberment were real threats lumbermen faced daily and became something that loggers would expect on the job and a part of the masculine logger archetype. Working-class men played a role in dominating nature, providing an acceptable outlet for male aggression and another way for men to assert their masculinity (Rotundo 1993, 176). La Chasse-Galerie reinforces the dangers of the trade and the fine line between life and death as the painting depicts an uncomfortably close encounter with the devil, showcasing the masculine bravery needed to succeed as a logger. This folktale and painting also showcase how dealings with the devil are not worth risking damning one's immortal soul for an eternity, especially for something immoral like drinking. In other words, these stories demonstrate that to be pious is to work hard and endure the difficulties of working in isolation, as salvation comes to those who give glory to God since hard work will be rewarded by eternal inheritance from the Lord (Colossians 3:23–24, King James Version). Additionally, the dangers loggers face daily would lead to the importance of penance, piety, and prayer, as one would want to ensure that God would care for their soul if an untimely end were to suddenly and unexpectedly befall a lumberjack.

Figure 3 depicts the loggers excitedly heading towards a bright and lively city, wearing clothes to protect them from the harsh winter climate of Canada. These lumbermen have a sense of camaraderie and work together as a team to arrive safely in the city. They are enthusiastic about leaving behind the desolate and cramped shanty to socialize, shake off the feelings of isolation, and partake in a stress-

FIGURE 3 – *La Chasse-Galerie - Légendes Canadiennes (Julien 1900). Image of artwork made with ink, wash, white chalk, and gouache on paper.*

free night of dancing, drinking, and debauchery. While travelling into town, the lumberjacks work together to descend upon the unsuspecting townspeople for a night of wild fun and socialization with women. The sky is clear, the stars are bright and visible, and any potential danger is out of sight and out of mind. Figure 3 depicts teamwork and camaraderie, while Figure 2 showcases violence and danger as the devil is at the helm and leading the canoe astray due to the immoral irresponsibility of the canoe's navigator, much to the shock of the rest of the lumbermen. To save their souls, the other loggers must silence the navigator through any means necessary, even if that means being violent towards a fellow logger. The danger of falling from such great heights relates to lumbermen's risk when climbing giant white pine trees to fell tree limbs and the daring they would have to embody to succeed in their work. In contrast to Figure 3, the background of the painting in Figure 2 is dark and unwelcoming, and there are no more stars to help guide the loggers safely back to their shanty. Instead, the skies are ominous, with clouds beginning to cover the little light the moon had provided. The darkness can be interpreted as a symbolic representation of Christian evil, the dangers of dealing with the devil, and the consequences of transgressions of Christian masculinity.

Although these are folktales and artistic representations, they demonstrate the real violence experienced by lumberjacks. This violence in the lumber camps was well known as "accounts of the cramped quarters describe the collision and fusion of different cultures and temperaments. The expression "he's got a chip on his shoulder" dates back to when a man who was itching for a fight in the cabin-fever confines would put a wood chip on his shoulder and dare anyone to knock it off" (Holdsworth 1995, 15). Camp bosses banned liquor in shantytowns by the mid-nineteenth century; however, it did little to change public perceptions of loggers as rough and rowdy drunken delinquents. (Gillis and Parks Canada 1975, 140–141). Once the log drive was complete, lumberjacks would flock to nearby townships to let loose and destress after months of sobriety, isolation, and challenging working conditions. These conditions remain similar to the spending and alcohol consumption in modern resource extraction industries, especially in remote sectors that need to fly, drive, or bus in the majority of their workforce (Lee 2006, 187–188; Ennis and Finlayson 2015, 55–57). Although lumberjacks were often sober during winter, the public only saw them when they were drinking in local towns. In addition, violence in the early to mid-nineteenth century was also partially due to fierce competition between well-established French loggers and newly settled Irish-Catholic immigrants. This brutal competition led to the Shiners' War, which lasted between 1835–1845 (Lee 2006, 188–192). The Shiners' War, with the aforementioned logging legend Joseph Montferrand leading the French, further led to public assumptions about violence in the logging industry and the flow of liquor throughout the camps (Lee 2006, 188–191). Logging folklore and related artworks acted as a vehicle for disseminating knowledge to the public about the daring and delinquency of the Canadian lumbermen. They solidified ideals about how a real man can throw a punch, hold his drink, and look death in the face daily while continuing to endure hardships and maintain their work – a trend that has continued in contemporary resource extraction industries (Goldenberg et al., 2010, 161–163; Carrington, McIntosh, and Scott 2010, 405).

The debauched actions of loggers returning to civilization seemed to confirm the depictions already present in the folktale of La Chasse Galerie and Julien’s artwork in the public's eyes. Loggers were already publicly perceived as an immoral bunch, and published folklore had helped to further transform loggers into walking manifestations of the dangers of liquor and sin. The story and the

folktale's artistic depictions (Figure 2 and Figure 3) showcase how bad things occur when piety to God has been forgotten or forsaken, even if there is excitement and gratification. The sketch, painting, and tale of La Chasse Galerie showcase the lack of access to liquor in the camps and the desire the lumberjacks had to let loose, have fun, and participate in celebratory libations. There are implications that the lure of a night of drinking, dancing, and daring merrymaking seems too difficult to resist to these isolated men, regardless of their religious convictions. Piety to God and adherence to morals seem to be lost on these lumberjacks as they enjoy themselves in the city, forgetting that they will have to safely navigate back to the isolation of the forests without breaching the contract made with the devil. These manifestations were further solidified in the eye of the public, as once the logging season had ended and men returned to populated towns, after months of no liquor, they wanted to spend their paycheques and enjoy themselves (Lee 2006, 182). Themes that appear in Julien's artwork can be related to themes of masculinity in resource extraction industries today, including the practice of bringing in workers from outside the work region, prevalent violence in work camps, and the copious amounts of alcohol and drug consumption when off work (Carrington, McIntosh, and Scott 2010, 395, 405; Ennis and Finlayson 2015, 55–57).

Labourers working far from home "expressed their sense of skill—and thus their manliness—through initiation rites, story- and myth-telling, and occupational language" (Quan-Wickham 1999, 137), leading to a distinct cultural phenomenon of masculine ideals and traits that became synonymous with working in the resource extraction industry. The meaning and function of masculinity were tied to skill in the nineteenth century. Thus, "masculinity was able to control the pace of production" (Maynard 1989, 162) and provide men working in the industry with something aspirational. In these all-male workspaces, legend served as a vehicle for producing and reproducing working-class masculinities that exemplified bravery, skill, agility, strength, and an uncompromising attitude. Further still, the language of westward expansion and the developing nation-state of Canada itself was gendered from the very beginning of colonial conquest – men were on a mission to conquer mother nature by clearing the land of her forests, preparing for the so-called 'civilized' man to settle in the newly created farmlands, language that Canadians continue to see today in resource extraction industries (Quan-Wickham 1999, 135; Parsons and Ray 2020, 248–251, 266–267).

Men working in the resource extraction industries often viewed the working conditions as a masculine ideal, glorifying the courage needed to succeed and idealizing the risks to life and limb in the remote woodlands (Baron 2006, 152). Recognition of the life-threatening dangers that loggers undertook each logging season, their work to clear the land for agriculture and settlement, and offering contributions to the economy further entrenched their importance to the developing Canadian nation-state and national narratives. Many loggers also participated in agriculture. As Deryck Holdsworth demonstrates, "these brutally strenuous winter logging camps stayed male throughout the nineteenth century, but they too were linked—for some married men—as a seasonal wage environment to pioneer farms" (Holdsworth 1995, 15). The danger was well-known, but labourers and farmers would often return to logging each winter until spring when more experienced loggers would take charge of the log drive (Lee 2006, 183–184, 194). The embodiment of danger is still seen in primarily male workplaces in resource extraction in the twenty-first century. For example, men in the resource extraction industries today often deal with working long hours, spending weeks to months at a time away from home, working in close quarters with other men at camp, having

a minimal choice in terms of food, the proliferation of ideals of toxic masculinity, and storytelling for entertainment (Quan-Wickham 1999; Shaughnessy and Krogman 2011, 139–141; Ennis and Finlayson 2015, 53–57; Parsons and Ray 2020, 259–263).

In conclusion, La Chasse Galerie and Joseph Montferrand are an integral part of the history of the Ottawa Valley and Canadian folklore. Analyzing working-class storytelling and subsequently inspired artwork can help illustrate the production and reproduction of masculinity. Masculinity, tied to alcohol, dangerous working conditions, physical strength, and isolation, became an ideal for aspiring to and a characteristic to be feared. Risk-taking became a core piece of many masculine identities (Mosse 1996). Studying the representations of the Canadian lumberjack in folklore and folk art can show how ideas of masculinity emerged through oral, textual, and visual mediums, which helped shape conceptions of gender roles and working-class masculinities in Canada today (Baron 2006, 145–146). The construction industry, long-haul trucking, mining, and oilfields all embody masculine qualities exemplified within narratives of logging folklore and depictions of lumberjacks in Julien's artwork, such as being far away from home and isolated from familiarity, regular encounters with danger, and working long hours for an extended time. Julien's sketch and painting inspired by La Chasse Galerie helped further entrench ideas about the logging industry and those who worked within it, as visual representations of loggers solidified a particular lumberjack motif that has remained popular across Canada.

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RESEARCH ARTICLE

"Our Lives as Women": An Analytical Framework of What Makes Q'eqchi' Women Sick

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ABSTRACT

The global pattern of women suffering from worse health than men, based on cultural, economic, and biological factors, was found in a small group of Q'eqchi' women in the Toledo district of Belize. This research follows the health narratives of 20 Q'eqchi' women to determine what they believe causes their poor health. Through in-depth personal interviews Q'eqchi' women shared that they suffer from backaches, headaches, pain in their bones, and heavy bleeding. Further, the women also reported 'thinking too much' as a factor in their health caused by their reproductive roles. Through thematic analysis and an extensive review of varied literature, this research found that the colonization-rooted Latin gender roles of machismo and marianismo work to sustain Q'eqchi' women to the domestic sphere. Based on the fact that most Q'eqchi' women are mothers and wives, these women are stripped of opportunities to obtain education and gain employment, leading to high stress levels and a dependency on their partners for socioeconomic support. Moreover, Q'eqchi' women's domestic responsibilities involved arduous physical labour with little rest or help from their male spouses. This labour, combined with the pressures and responsibilities associated with their sex, results in their somatic and psychosomatic expressions of sickness. The research presented in this paper underpins the significance of women's sex and cultural systems when analyzing global health outcomes. More nuanced considerations of cultural structures, like those mentioned by Q'eqchi' women, need to be prioritized by policymakers and global health initiatives internationally to better support women's health.

Keywords: Q'eqchi', medical anthropology, gender roles, marianismo, machismo, health, culture

INTRODUCTION

An examination of the largest available multi-country population-based survey of self-reported health showed inequality in the health status of men and women. Women consistently having comparatively poorer health than men (Hosseinpoor et al. 2012). Internationally, evidence demonstrates that social and cultural factors such as one's social status, personal values, income, and biological factors as well as one's predisposition to illness, all negatively impact women's health more than men (Hosseinpoor et al. 2012). The concepts of machismo and marianismo are vital to this research and determine the social expectations of someone depending on their gender identity. These concepts are not unique to the Q'eqchi' people, as they are dominant cultural concepts shared in Latin American communities. However, these concepts are deeply influenced by the Spanish colonization of the Americas (Hardin 2002). Indeed, the stereotype of machismo is both an interpretation and response to the ideas of gender and social roles of pre-colonization Latin American cultures (Hardin 2002). Machismo emerged from the Spaniards violence against indigenous women, indigenous imperial ritual, and the sublimation

of indigenous male sexuality (Hardin 2002). This paper analyzes the lives and self-reported narratives of Q'eqchi' women in the Toledo district of Belize to better understand their perception of what makes them sick.

The results of this study show that the local level of self-reporting of health outcomes for Q'eqchi' women reflected the global pattern (Hosseinpoor et al., 2012), where Q'eqchi' women repeatedly reported experiencing worse health than their male counterparts. I developed a framework to identify factors that influence their perception of inequitable health outcomes based on gender roles based on what the Q'eqchi' women expressed in interviews and an extensive literature review. I rely on the emic perspective of Q'eqchi' women to counterbalance dominant western ideals and attitudes on the health of these women. Through analysis of in-depth personal interviews, and in conjunction with supporting literature, I argue that the most significant cause of Q'eqchi' women's sickness is best understood within the prescribed Latin gender roles of machismo and marianismo, as imposed by European colonizers[1]. In doing so, this research aims to broaden knowledge on how the interception of gender and culture affects health.

ETHNOGRAPHIC CONTEXT

Belize is a small Central American country, bordering Mexico to the north, the Caribbean Sea to the east, and Guatemala to the west and south (Murray, 2020). Important to this article is the history of colonization, first by the Spanish and then the British, as Belize only gained independence in the late 20th century. Belize is an ethnically and culturally diverse country, including groups such as the Mestizo, Creole, Maya, Garifuna, and Mennonite (PAHO 2012). The Maya people are equally diverse, as they can be distinguished as Q'eqchi', Mopan, and Yucatec in Belize (Murray 2020). Many of the Q'eqchi' Mayas migrated to Belize in the latter half of the 20th century due to the civil war in Guatemala from 1960 to 1996(Kockelman 2010, 7). Despite the recent decline in poverty, the Toledo district remains the poorest district in Belize (PAHO 2012).

Toledo's unemployment rate was 6.8% as of April 2018 (SIB 2018 18), though the rate is higher for woman (11.3%) than men (4%) (SIB 2018 18). The number of men employed in waged labour (8228) in the Toledo District is double the number of women (4748) (SIB 2018, 20). When discussing employment and money within this paper, it should be recognized that the majority Q'eqchi' women interviewed were responsible for the unpaid labour of housekeeping and child-minding, meaning they are not compensated for the work they perform. The significance of paid labour for women in Belize is an essential factor in experiences of sickness, as Q'eqchi' women express in this data.

In addition to these economic relations of gender norms, maternal mortality rates increased from 41.8 to 55.3 deaths per 100,000 live births (PAHO 2012). Contraceptives have been linked to better maternal health outcomes in Belize, but there is a disparity among the districts in access and usage of contraceptives. The highest rate of contraceptive use is I the district of Belize at 47.5%, whereas, in Toledo, the use of contraceptives is only 23.4% (PAHO 2012). Multiple factors could influence this including transportation to clinics, affordability, and the level of autonomy women have in making health-related decisions. This is significant as it illustrates women's inaccessibility to healthcare, specifically Q'eqchi' women, challenging the rights to which they are entitled.

Gendered health issues also include the frequency that women experience domestic

[1] Q'eqchi' women did not use the words marianismo or machismo in their interviews. However, what the women identified as causes of their sicknesses were all related to their gender and the work that is expected of them as outlined in literature pertaining to machismo and marianismo.

violence. Domestic violence cases in Belize increased from 968 in 2006 to 1,477 in 2010 (PAHO 2012). Understanding the ethnographic context of Belize, and especially the Toledo district, is imperative to understanding how Q'eqchi' women experience sickness. There is limited data available regarding Q'eqchi' women's health, possibly due to their remote location. Taken together, this paper shows how poverty, gender inequality, and the dispossession of Q'eqchi' lands, all continue to impact the culture of Q'eqchi' people within Belize, which contributes to negatively impacts on Q'eqchi' women's health.

Methodology

This paper is predominantly based on James B. Waldram's[2] ethnographic, in-depth interviews. The interviews of the Q'eqchi' women took place in the Toledo district of Belize in 2013. The research was designed to uncover how Q'eqchi' women understand the Q'eqchi' medical system and the distinctions between men's and women's health. Two types of interviews were conducted: in-depth personal interviews and pile sort interviews[3]. The in-depth personal interviews enabled researchers to gather key information from demographic information to personal experiences of health and sickness shared by the Q'eqchi' women. Waldram used various interview types to conduct this research, but only the in-depth personal interviews and a selection of pile sorts will be analyzed in this paper.

This paper utilizes the twenty-one interviews were conducted with 20 different Q'eqchi' women, one woman being interviewed twice. A female [4] graduate student asked the questions in English. The translator asked the questions again in Q'eqchi' and then translated the participant's answers back into English for the researcher to understand. A language specialist, an additional researcher who was not part of the community, fully translated the interviews into English while listening to the recording and translated the answers into English. Due to the language barrier, there are some variations and additions in the translation provided and grammatical and syntax adjustments for the excerpts of the interviews provided in this paper.

The interviews provided vital data to this research as the women could share insights into their real-world perspectives and experiences. A latent level of thematic analysis was utilized and required the researcher of this paper to uncover the underlying ideologies and ideas that form the semantic themes the participants explicitly stated (Braun & Clarke 2006). During the coding process, I coded for all health symptoms Q'eqchi' women discussed, such as 'backache' and then grouped all expressions of sickness under the broad theme of "women's health symptoms." I applied this analytical framework to the interviews to develop a qualitative analysis of their findings. The thematic analysis enables researchers to examine valuable information on people's perceptions of their health rather than stating statistics (Braun & Clarke 2014). In conjunction with existing data on women's health in Belize, thematic analysis contributed to developing an explanatory model for what Q'eqchi' women understand makes them sick.

To code the data within Braun and Clarke's latent thematic analysis model, I used NVivo software the University of Saskatchewan provided (released March 2020) (Braun & Clark 2014). There were nine themes identified, varying from women's health symptoms, cultural understandings of illness, relationship

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[3] In-depth personal interviews are a qualitative research method used in social sciences which allow the results of research to be explained by the participants (Maman et al, 2014).

[4] Previous researchers have been anonymized throughout this paper.

status, and the impact of education, employment, and children on health. Some of the themes were then divided into subcodes, for example, Income impact on Health was divided into three codes; money related to health via the cost of healthcare, food, and as a cause of 'thinking too much.' The most significant theme, Cultural Understandings of Illness, included eight codes.

Finally, I consulted literature on gendered impacts on health, such as domestic labour and intimate partner violence, and literature on gender roles in Q'eqchi' communities, before and after the Spanish conquest. I critically analyzed literature on social, biological, political, and historical academic work as a holistic perspective is central to anthropological research. Therefore, I analyzed a collection of literature on the health and roles of Indigenous women and gender roles within Latin communities for this research. Using anthropological work, government databases, and educational and public health resources as sources, I argue throughout this paper that the enforcement of gender roles is used to sustain the systemic marginalization of women, thus resulting in their poor health.

RESULTS AND DISCUSSION

Q'eqchi' Gender Roles: Machismo and Marianismo

This paper analyzes the impact that gender roles have on the health of Q'eqchi' women. Differences in expectations of behaviour and roles of gender are culturally determined (Pinos et al. 2016, 17). Gender roles are the social guidelines provided to new generations. As such, adolescents are enculturated into the gender role system and grow to impose them on the next generation (Pinos et al. 2016, 17). Gender roles are imperative to understanding why Q'eqchi' women get sick, as they dictate the type and amount of work expected of men and women, who has control over women's bodily autonomy, and who can make health care decisions. In Western contexts, typical gender roles can be understood in terms of the stereotypical 1950's nuclear family[5], with a home-making wife (domestic) and breadwinning husband (public). Although gender roles in some Western cultures have changed throughout time, other cultures have maintained more 'traditional'[6] expectations of men and women, which are examined here.

The gendered division of labour plays a significant role in determining the 'negotiations of power and status between men and women' in Maya society (Re Cruz 1998). Alicia Re Cruz, who studies the gender dynamics of the modes of production in Mayan communities[7], understands these negotiations as part of women's dependency on men and lack of autonomy that Q'eqchi' women experience. To highlight the gendered division of labour, I outline the tasks expected of Q'eqchi' men, such as earning money for the family, and connect these to the tasks expected of Q'eqchi' women, such as bearing and raising children and doing all domestic labour. This paper connects these tasks to the health of Q'eqchi' women and their expressions of sickness.

"Good Men Grow Corn": Machismo and Expectations of Q'eqchi' Men

The title of this section is from Kristina Baines, a medical anthropologist, who chose this quote to convey the nuances behind how 'good' is conceived in Maya communities. Gender roles lay out prescribed behaviours and attitudes thought to best highlight one's biological sex to maintain the status quo and expectations within a given culture. Machismo refers to the patriarchal structure in Latin America

[5] Nuclear family referring immediate heteronormative familial relations such as mother, father, son, and daughter.

[6] 'Traditional' here being defined as more historically synonymous, where women were expected to work from home and the men held jobs, while acknowledging that these 'traditional' roles were highly impacted by the colonialism.

[7] Mayan communities are diverse and include groups such as the Q'eqchi' people.

whereby men are viewed as having rightful dominance over women (Wands et al. 2020). As a stereotype, machismo encourages men to express hyper-masculinity, such as virility, strength, and hegemony, usually through physical and sexual aggression (Wands et al. 2020). Q'eqchi' men are thought to be strong and courageous, whereas women are perceived as 'vulnerable and weak' (Re Cruz 1998). 'Good' Q'eqchi' men are providers, and it's their job to grow food and earn money for their families.

The expectation for men to be the providers was captured in an interview with a Q'eqchi' woman named Maria, who associated money, food, and education with men, not women. Her response gave invaluable insight into her perspective on gender, money, food, and education. Maria's response translated as such, "She said most men think about money, education and food, because we as the women just wait for that from the men, the men have to get those" (Maria, 2013). Further, when asked who would be impacted more regarding lack of money, one participant explained the stress she feels when her husband refuses to work. Another Q'eqchi' participant, Rebecca added, "Well we as the women maybe the man works for a week gets his money and doesn't want to go and look for a job again… it's we the women (who) sees what we need for the kitchen and for children needs it's not the men. It might be good for the men he only wants to eat everyday but doesn't want to work." (Rebecca, 2013). These excerpts show the connections Q'eqchi' women make connections between masculine gender roles and the procurement of income for food, education, and the stress they feel when they are unable to earn money for themselves. In the interviews, it was noted by some Q'eqchi women that some Q'eqchi' husbands prohibit their wives from entering the workforce. Therefore, there are Q'eqchi' women who cannot gain independent income and are forced to rely entirely on men for survival which perpetuates power imbalance within marital relationships.

Marianismo and Expectations of Q'eqchi' Women

If "good men grow corn," what makes a Q'eqchi woman 'good'? The answers Q'eqchi' women gave relate to the implications of *marianismo.* Marianismo, the sister concept of machismo, encourages women in Latin America to express hyper-femininity through selflessness and motherhood (Wands et al. 2020). Two fundamental values dictate expectations of female behaviour*; simpati* [8] and *familismo*[9] (Wands et al. 2020). Although some theories state marianismo was a response to machismo, Ehlers argues that abiding by marianismo expectations serves as a female survival tactic as men hold all forms of institutional and social power. Women must act in the way that is expected by men, as the men withhold their right to economic security by mandating that the women subscribe to gender roles that perpetuate their marginalization (Ehlers 1991). Further, marianismo is based on maintaining women in the domestic sphere, making Q'eqchi' women's rightful place in the home. Women's domestic responsibilities include processing and preparing crops for eating and selling, collecting, and processing wild plants, caring for all domestic animals, getting water, washing clothes and dishes, and caring for all children in the house (Baines 2016). Although this labour is vital to the community, it's undervalued by men as it does not provide any additional income (Ehlers 1991). The expectations can of women can be traced to the colonial period through Ehlers (1991) and Hardin's (2002) work, as marianismo emerged

[8] Simpatia is where women should be agreeable and non-confrontational.

[9] Familismo is where the primary concern of any woman should be the well-being of her family.

through the colonial imposition of machismo. Q'eqchi' women understand their work to be part of their femininity and positions as mothers and wives, despite the health consequences. Many Q'eqchi' women discussed this during their interviews, as Felicity said, "(We get sick) Because we have a lot of work today, especially (with) our children."

Overview of Gender Roles and Health Implications for Q'eqchi' Women

The impact of machismo and marianismo, as set in place by the history of European colonialism, is felt by women in multiple ways. Figure 1 shows two categories that influence Q'eqchi' women's health, machismo and marianismo. Under machismo, women expressed four themes believed to make them sick: lack of education, employment, independent income, and autonomy. Additionally, to explain why they get sick, women expressed their inherent weaknesses and inferiority to men in their interviews, as stated by values expressed through machismo.

The next category influencing Q'eqchi women's health falls under marianismo. There are four themes Q'eqchi' women express as an explanation for their health related to their womanhood: domestic labour, childrearing

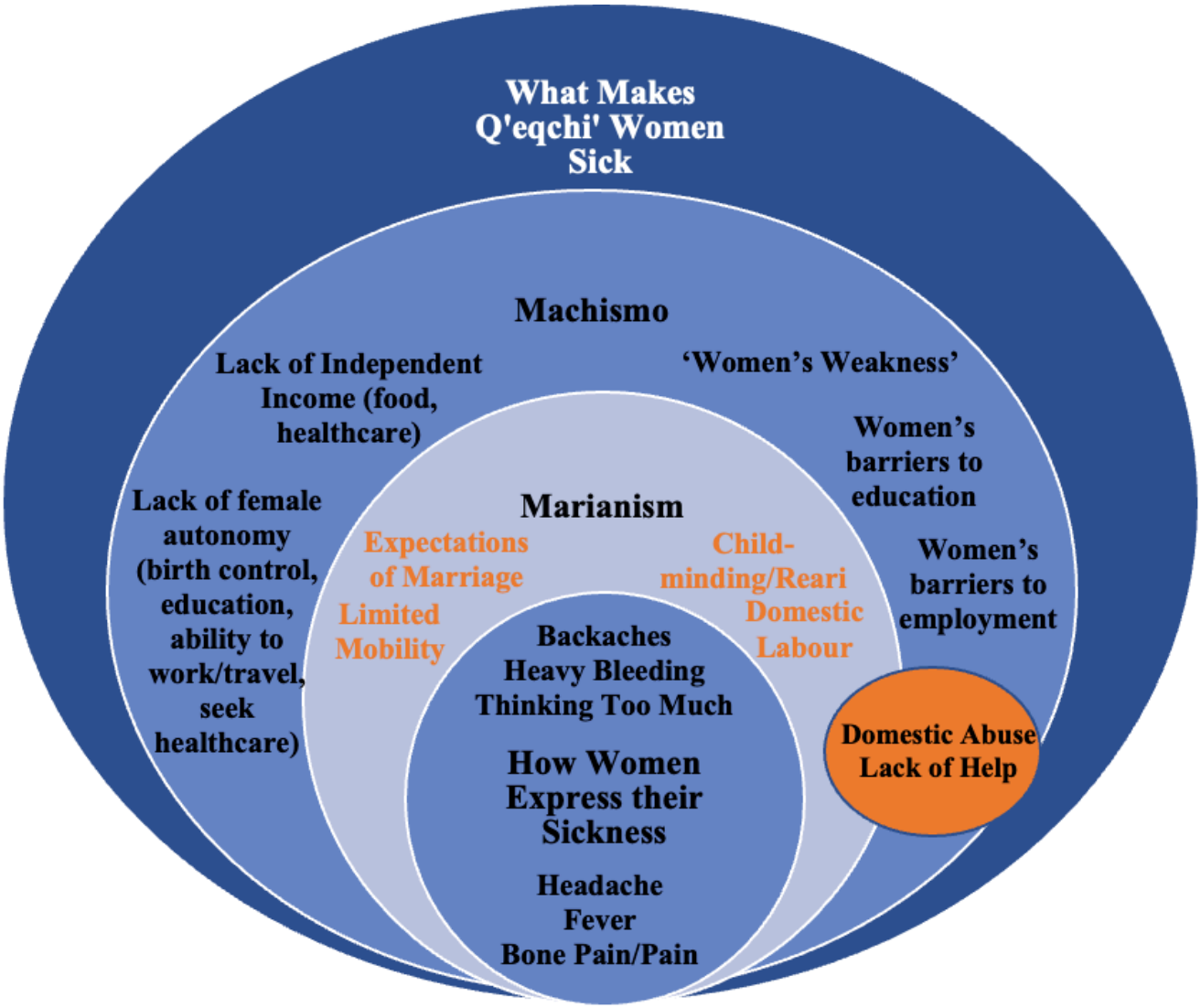

***FIGURE 1**: Schematic Analysis of how Machismo and Marianism lead to Q'eqchi' Women's Sickness (Created by author).*

and minding, limited mobility, and expectations of marriage. The graphic shown in Figure 1 demonstrates that machismo (the overarching patriarchal structure), predetermined the expectations of women, including their domestic responsibilities, which is understood as the main cause of women's sicknesses. Indeed, their responsibilities directly lead to their expressions of sickness.

In Figure 1, a small circle straddles the intersection of both machismo and marianismo. Domestic unrest, named to cover the various terms to describe discordance in the home, is maintained as a health problem due to both machismo and marianismo. Machismo encourages hyper-masculinity expressed through physical and sexual violence against women. When discussing certain sicknesses, a Q'eqchi' woman Victoria, elaborated on why they get sick stating "the men like to hurt the women. That is why they could catch sickness so fast… because the women would think like why would the men like to do that?" (Victoria 2013). Correspondingly, marianismo and hyper-femininity, through being submissive and non-confrontational (simpatia), restrict actions that Q'eqchi' women can take to remove themselves from an abusive home (Wands 2020). Included in the circle is 'lack of help' as men work outside of the domestic sphere, and women are solely responsible for all domestic labour to keep their family running smoothly[10] (familismo) (Wands 2020). This domestic unrest and lack of help impact Q'eqchi' women's health due to the interrelationship between the expectations of machismo and marianismo.

There are three levels of analysis to consider when answering what makes Q'eqchi' women sick. The first is the overarching patriarchal influence of machismo, which ultimately defines women's lack of socioeconomic movement, where social and gender norms demand that women work exclusively within the domestic sphere. The second level examines the consequences of the patriarchal structure and Q'eqchi' women's restricted socioeconomic movement. Such consequences include the expectation of women to become homemakers, where they are solely responsible for domestic labour, often with domestic unrest occurring in their home, which leads to their sicknesses. The last level is the culmination of levels one and two, how Q'eqchi' women express their sicknesses through somatic and psychosomatic expressions and idioms of distress, whether their sickness is due to domestic violence, domestic labour, or childrearing. The innermost circle in Figure 1 represents the symptoms felt by Q'eqchi' women due to both machismo and marianismo. This research explores this theory in-depth using data derived from the interviews of Q'eqchi' women and supporting literature.

Machismo as a Catalyst for Q'eqchi' Women's Health Experiences

To follow the impact of machismo on the health experiences of Q'eqchi' women, researchers must observe the relationship between education, employment, and independent income, as seen below in Figure 2.

To observe this relationship, Q'eqchi' women were asked questions regarding education related to their health and their level of education. Alex, for instance, was asked by the female graduate student "Do you think it is easier for males to go to university?" Alex replied, "Yes, because there is no reason for females to go to university. Well, in our culture females going to university and whenever they graduated, they still end up living with a male and married so what is the sense or reason in going to university without getting a job?" (Alex 2013). In this excerpt, Alex identified

[10] Insight into whether Q'eqchi' women work collectively or independently to complete their domestic labour is outside the scope of the paper, due to the focus of the original research this paper is based on. However, it would be a fruitful area of feminist research in the future.

the systemic conditions that allow for men to receive an education over women and the connection between education and employment.

Q'eqchi' women are well-aware that education is needed for employment; however, Q'eqchi society believes that even with an education, a Q'eqchi' woman is not destined to work outside the home. Therefore, it's perceived by many Q'eqchi' women that maternal and spousal duties are inevitably prioritized over formal education which is a privilege reserved for boys.

Education being 'wasteful' and 'too expensive' for women was repeated in Yanira Oliveras-Ortiz's research on education in Maya communities. According to Oliveras-Ortiz, education is perceived as unnecessary for their subsistence-farming community (Oliveras-Ortiz et al. 2020). In this study Mrs. Po, a principal at a Mayan school, repeats the cultural preference for men to attain education, as it's believed that girls should stay home to look after younger siblings or start their own families (Oliveras-Ortiz et al. 2020, p. 47). According to Margorie (one of the Q'eqchi' women interviewed), teenage girls are taken out of school when they become pregnant, although the fathers can continue to study (Margorie 2013).

Education, income, and occupation are all critical factors in determining access to control over power and resources (Hosseinpoor et al. 2012). Studies on social determinants of health reinforce the fact that education, occupation, and income measure an individual's socioeconomic resources and social position all effect an individual's health (Braveman et al. 2014). Social determinants of health are further complicated for Q'eqchi' woman as not all Q'eqchi' women receive formal education, and most do not have an occupation that provides an income. Therefore, their socioeconomic resources and social position is at a low level resulting in negative health outcomes.

The expectation of women working in the domestic sphere and the preference for men to get educated creates a systemic barrier for Q'eqchi' women to have the qualifications to gain employment and socioeconomic mobility. The lack of independent income adds undue stress to Q'eqchi' women's lives because if their husband does not work, there is no way to support the family financially. When a Q'eqchi' woman named Daisy was asked why a lack of money might impact a woman more than a man she responded, "The woman, because maybe she is married, she doesn't have money and her husband doesn't want to work and the children would want stuff and you can't give them, and the mother start to worry." (Daisy 2013). Daisy recognized that Q'eqchi' women cannot earn money, and if the husband does not work, the mother feels the stress of providing for the family without the socioeconomic means or social position to do so.

Multiple women expressed that money is a significant barrier to good health, as transportation to and the procurement of healthcare is often too expensive for the women. Rose, a Q'eqchi' woman, responded to how money impacts heath by saying, "Yes it's difficult, you might let a family member die because there is no money to help the sick person. If you have money then you can go to Belize City or Guatemala, just to try." (Rose 2013). Q'eqchi' women rarely make independent income due to the men maintaining dominance over women in economic and educational institutions, which controls not only female independence, but consequently decides if a woman gets to live or die (Ehlers 1991).

Marianismo as an Explanation for Q'eqchi' Women's Sickness

Q'eqchi' women's restriction to the to the domestic sphere negatively impacts their health, as set in place by machismo and its impact on women's education and employment (Figure 2). Q'eqchi' women had two primary

responses to what made them sick: domestic labour (including childminding and rearing), and domestic unrest. From the perspective of Q'eqchi' women, domestic labour and children impact their health as expressed in an interview with Delphina, who claimed "(Women) don't have a rest; they don't rest their body. Especially when you have a lot of children, you don't have rest for a minute." (Delphina 2013). Q'eqchi' women mentioned domestic unrest multiple times when discussing their health and pain. For example, when asked why so many Q'eqchi' women experience back pain, the interpreter translated one response- "With gender abuse, most of the time, men hurt the women and that causes back pain." Keeping the accounts of the Q'eqchi' women at the forefront of this research, I elaborate on how domestic labour and domestic abuse are central to making Q'eqchi' women sick.

Children have also impacted Q'eqchi' women's health decisions, as Rose, a Q'eqchi' woman with eight children, described in her interview. Rose decided against having surgery that a biomedical doctor suggested. When asked why, Rose said "I didn't want to get cut[11] because I have a lot of children to take care of and they want to eat and I have to wash clothes, and how will I take care of them (if) I get cut? That's what I thought of, so I went to the bush doctor." (Rose 2013). As a result of being solely responsible for all domestic tasks, Rose had to make health decisions that allowed her to continue to fulfil her role as a woman as dictated by marianismo. In addition to children's impact on healthcare decisions, many women reported needing their husbands for permission to seek health care and birth control, providing an example of the lack of autonomy Q'eqchi' women have over their health and bodies.

Diane expresses another example of how domestic labour influences the health of Q'eqchi' women, stating that women are not healthy like men. When asked why, her answer was informative; "The women they do work for the children, and they do hard work to take care of the children and to do the house cleaning they do hard work. And then the backbone might hurt and anything like fever, it is easy to get it because she is working, working, more than the male." (Diane 2013). When the hard labour women do is compounded with the lack of rest and help, women often begin to feel sick.

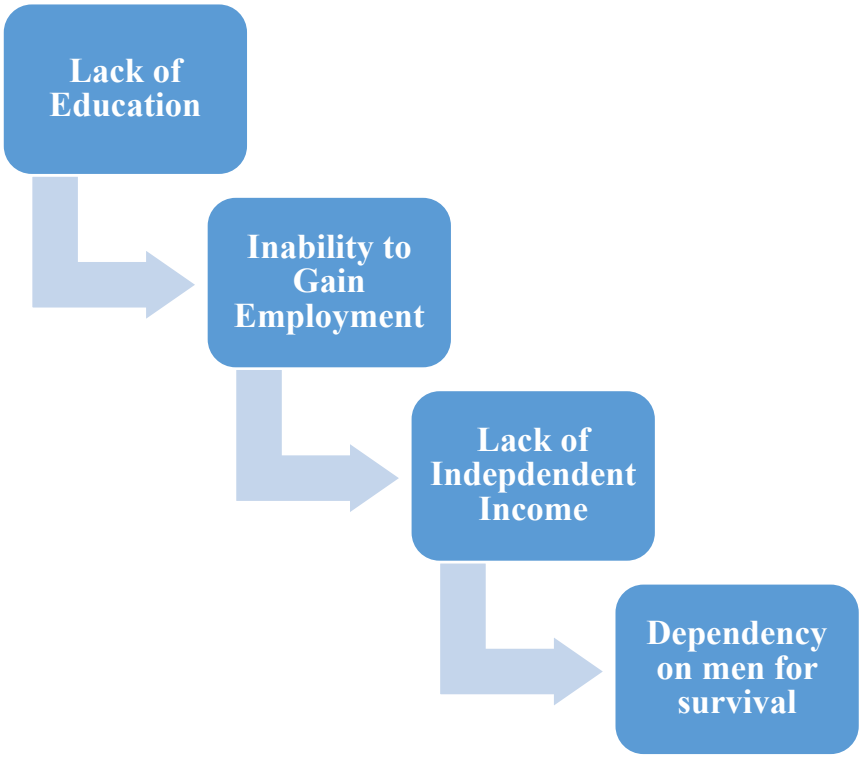

FIGURE 2 - *Relationship among Education, Employment, Independent Income and Women's Dependence (Created by author).*

[11] "Get cut" refers to undergoing surgery.

Globally, Indigenous women like Q'eqchi' women in Central America, experience adverse health effects based on the domestic labour they perform in their respective regions (Waters et al. 2018). This is partly explained by the double burden of the expectation for women to perform both productive and reproductive roles (Waters et al. 2018). Q'eqchi' people believe that blood loss during pregnancy, labour, and menstruation results in weakness for women. The weakness associated with blood loss further cements both Q'eqchi' men and women's beliefs that women are inherently weaker due to the bleeding associated with the reproductive roles they are expected to perform (Berry 2006). Significantly, this belief supports the continuance of the patriarchal society, which negatively impacts Q'eqchi' women's health.

Worldwide, women provide 43% of the agricultural labour and between 85% to 90% of the food preparation and child-care required to sustain human life (Waters et al. 2018, p.221). This demonstrates that women's labour is vital to the well-being of rural small-scale agricultural households, making women vulnerable to serious health effects (Waters et al. 2018, p. 224). Many men work 'temporary and cyclical' off-farm wage jobs, which barely reduces women's stress (Waters et al., 2018, p. 221). The adverse health effects due to women's tasks are supported in Diaz et al. (2005) research on the symptoms of Indoor Air Pollution (IAP). This research demonstrates that burning wood, animal, or crop waste is a global health concern, impacting mainly women as they cook in poorly ventilated indoor spaces. The burning of biofuel leads to IAP, which is linked to experiencing headaches and backaches (Diaz et al. 2005). Ergo, the lived experience and accounts of how domestic labour and childminding/rearing impact Q'eqchi' women's health is substantiated throughout various research.

The second theme identified as a cause of Q'eqchi' women's sickness was domestic unrest, that is associated with machismo, marianismo, and Q'eqchi' women's lack of mobility. Domestic unrest is complicated by Q'eqchi' women's lack of mobility, as expressed by Alex, "When I have domestic family problems and I wonder what it would be like to have a job and not have children, rather than having this man stress me out with these problems." (Alex 2013). Most Q'eqchi' women do not complete their education or work outside the domestic sphere, significantly hindering their independent income and ability to leave an unhappy marriage. Moreover, Q'eqchi' women's desire to leave may be undermined by the values of simpatia and familismo , which places family harmony over the woman's needs and/or desires.

Domestic unrest can be attributed to machismo, specifically male aggression. Veronica, a Q'eqchi' woman, explains "Because the men like to hurt the women. That is why they (the women) could catch the sickness so fast." However, domestic unrest is exacerbated by the expectations of female behaviour within marianismo. Maya women are especially susceptible to intimate partner violence due to their intersectional position between race, gender, and poverty (Wands 2020). Poverty has been linked to higher rates of intimate partner violence through higher levels of stress and conflict, financial dependency, and drug and alcohol abuse, which was noted by Q'eqchi' women (Wands 2020). Q'eqchi' women are taught to be non-confrontational to maintain the values of simpatia and familismo, though two additional factors present in many Latin communities, restrict women's ability to leave abusive situations: sayra[12] and ximena[13] (Wands 2020). Although

[12] The blame a woman places on herself (Wands, 2020)

[13] Ximena refers to women's concern regarding their children, specifically how they will provide for them financially (Wands 2020)

these are not Q’eqchi’ Maya terms, the sentiments expressed by Q’eqchi’ women mirror the definitions of these terms. Rose’s interview demonstrates sayra. "Okay, to me, it’s only with food,” Rose says, “When a woman cannot do her work or chores at home and the husband reach (home) and the home is not clean, she could be abused.” (Wands 2020). Rose explains that abuse towards women occurs when women fail to perform their gender roles effectively. In Wands's research on Guatemalan women who experience intimate partner violence, one of her participants explains ximena, "The woman thinks, "I cannot leave him, because then how will I feed my children?” (Wands 2020). This statement is vital to understanding the complexity of Q’eqchi’ women’s experiences of abuse. Ximena, sayra, simpatia, and familismo all work together to make leaving an abusive home a transgression of their femininity and their skills as mothers.

Marianismo imposes the expectation of women to be reliant, submissive, self-sacrificing, and endure violence and adultery to preserve their value to men (Pinos et al. 2016, p. 18). Research on marianismo and its impact on intimate partner violence shows that it leads to poor health outcomes for Latina women both indirectly and directly (Da Silva et al. 2021). Domestic unrest and abuse lie in the intersection of male and female gender roles, as men's aggression encourages violence, and the expectations of women restrict their capacity to leave and support their children.

How Q'eqchi' Women Express Sickness

Q’eqchi’ women experience poor health due to their position in a patriarchal society that values machismo and male dominance. In this system, women work in the unpaid domestic sphere, where they are responsible for all household chores, such as getting water from the well, handling small farm animals, and minding the children. Domestic labour is hard physical work that can result in serious health effects, like exposure to IAP (Indoor Air Pollution), especially when compounded by their roles as mothers (Waters et al. 2018; Diaz et al. 2005).

Q'eqchi' women report six significant symptoms of poor health: backaches, fever, pains/pains in the bones, menstrual bleeding, headaches, and thinking too much. Diaz’s (2005) and Water’s (2018) studies explain these symptoms through the gendered division of labour, the impact of biofuel burning and the exacerbation of poor health due to their responsibilities. When asked why it was more common for women to get back pain than men, Elise, who has five children, responded, "You see how many kids we have, we are the ones that feels the pain for them during birth and that’s what cause us to get severe back pain and with the work we do at home." Moreover, women reported a lack of rest when asked if there were sicknesses that primarily women get. For example, Daisy asserts, "Actually, backache, headache and fever sometimes, when she works very hard, and she don’t get rest." The way women feel and express their sickness is crucial for understanding the impact of gender roles on women’s health.

Cultural understandings of sickness provide insight into how Q’eqchi’ women express and understand sickness, notably through idioms of distress. The primary example of this is “thinking too much.” This idiom of distress is of particular interest because although it’s caused by social issues, the women report feeling “thinking too much” somatically. Therefore, “thinking too much” is both a psychological and somatic sickness.

Q'eqchi' women cited thinking too much multiple times and identified diverse causes. One was the women's lack of money and the stress they felt surrounding supporting their family. Daisy shared her explanation for why women feel the pain of thinking too much more than men, explaining, “Because the women do everything, the kids want to buy this, they want to buy that, and they don’t have any

money and she have to think why is my life like this? Why is this my life?" Here, Daisy is questioning the position she holds in life, for if she were allowed to continue education, if she had not been expected to marry and have children, she realizes she could have a vastly differently life. At the root of most health concerns for these women lies the expectation of fulfilling their reproductive roles. If an individual seeks to improve the health of these women, one must trace these women's experiences of poor health back to the roots. Opportunities for independent income, skill-building, and an implementation of shared child-minding system may benefit the health of these women greatly.

Another significant cause for thinking too much was domestic unrest. Margorie shared her understanding of how women get sick from thinking too much, "Especially with problems, fighting, quarrelling, whenever you hear about those things you'll begin to think, and it can cause you to get sick. And when someone is drunk and when he gets home, he starts to quarrel and fight." Mary clarified that women experience "thinking too much" because of domestic abuse as well stating, "That is so because women tend to worry more about what happens, whether it's due to abuse by the spouse or anything that hurts feelings. Women suffer more than men because men do not worry about what happens to them." Thinking too much is not often used in international contexts; however, literature on this suggests a form of anxiety or depressive disorder (Baines et al. 2015). Q'eqchi' women who work in the domestic sphere experience "thinking too much" as an illness, but also experiences random pains, anxiety, and depression. As there are treatments available for these illnesses, and the cause of them are well-understood. Q'eqchi' women deserve the same supportive health initiatives that women who experience poor mental health receive around the globe.

Women, specifically Q'eqchi' women and other Indigenous women, use idioms to portray an embodied expression of distress (Yarris 2011). Idioms of distress are a way to express suffering among those who share 'ethnopsychologies'[14] (Baines et al. 2015). Idioms of distress are 'somatic forms of suffering' that are moral experiences, meaning that they're somatic complaints with social causes (Yarris 2011). In international contexts, thinking too much may be described as worry, stress, anxiety, sadness, or PTSD (Baines et al. 2015).

Q'eqchi' women express sickness through somatic explanations of their stress due to domestic labour and the precarious positions they find themselves in due to domestic unrest. Backaches, fevers, pains in the bones, headaches, bleeding and thinking too much all occur due to the overarching cultural structures that impose gender roles and tasks onto these women. As seen in Figure 1, the barriers to socioeconomic mobility due to machismo mandate that women perform unpaid domestic labour, which is compounded by their responsibilities that marianismo dictates. Combined, both gender roles impact the experience of health and sicknesses felt by Q'eqchi' women.

CONCLUSION

This research expanded upon the in-depth personal interviews of twenty Q'eqchi' women and utilized literature on domestic unrest, domestic labour, and gender roles to support the women's statements. The framework presented in this paper shows the ways that Q'eqchi' women's health experiences are dictated mainly by the gender roles and daily tasks imposed through the patriarchal values of machismo and marianismo. What makes Q'eqchi' women sick, according to Q'eqchi'

[14] In this context, "ethnopsychologies" refer to a shared psychology of a group of people.

women, are the responsibilities and expectations for them as women in patriarchal Q'eqchi' society.

As imposed by the Spanish and British, machismo dictates that men are dominant over women, barring the women from education and employment. Machismo then determines what is expected of Q'eqchi' women, defined by marianismo. Marianismo includes values expected of women: sayra, simpatia, familismo, and ximena. These expectations guide women's behaviour in terms of their daily activities, priorities, and, ultimately, their health care decision-making. Since women are not given the same opportunities as men, they are bound to and solely responsible for all domestic responsibilities, thereby excluding them from generating income for the family. Multiple women noted the lack of rest, child-minding/rearing, and hard work they do as the cause of their backaches, fevers, sore bones, and general sickness. Further, domestic unrest was shared by Q'eqchi' women as another reason for their poor health and the cause of the ever so common "thinking too much." Figure 1 demonstrates that what makes Q'eqchi' women sick is ultimately the consequence of machismo and marianismo, whereby the overarching patriarchal structure of Q'eqchi' culture, enforced by the colonial practice of Europeans, directly impacts women's health symptoms because of rigid gender roles.

The history of the Maya people and the economic and social conditions in Belize are two essential factors when examining the cultural explanations for Q'eqchi' women's sicknesses. First, to understand why Q'eqchi' women experience worse health, one must look at the colonial impacts on gender and gender roles for the Q'eqchi Maya. Researchers must approach these topics with the recognition of the far-reaching impacts of colonialism. Second, the availability to gain access to health care services are not straightforward and are heavily influenced by a myriad of internal and external factors. As stated previously, contraceptive use for women in the Toledo district is over 20% lower than in more wealthy regions in Belize. Accessibility to good health for Q'eqchi' women is hindered and exacerbated by their gender; whether it's a treatment for diabetes or receiving birth control, gender roles shape health outcomes and sickness experiences for Q'eqchi' women and men.

Developing this framework to expand upon patriarchal structures and gender roles underpins how gender is a crucial factor when discussing health and sickness and increases the comprehension of the role of cultural systems on health. I recognize that both men and women contribute to Q'eqchi' notions of health, including negative health impacts, therefore, I urge policy makers to use this research to formulate health initiatives that are meaningful to communities. One way to do this is to work with the community directly by inviting Q'eqchi' women to co-create health policies that are safe, practical, and effective Further, to better the health of Q'eqchi' women, it must be acknowledged that these women lack the autonomy and socioeconomic position to consistently make health care decisions for themselves without consulting their husbands or considering their children. Although this research is anchored within the context of Q'eqchi' women in the Toledo district of Belize, this research can be a steppingstone for future research to advocate and elevate the voices of women who are often left unheard and to aid in improving the health of others.

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REVIEW ARTICLE

Addressing the Alien in the Room: Why Public Perception is Imperative to the Field of Archaeology

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ABSTRACT

Pseudoscience in archaeology, or pseudoarchaeology, are ideas formed by distrust, with minimal observable evidence that explain the human past. In a world of widespread, accessible misinformation, researchers often dismiss the ideas presented within pseudoscientific theory as laughable or irrelevant. On the contrary, many of these thoughts are supported by and for colonialist or racist agendas. With popular media throughout North America now supporting pseudoarchaeology, misinformation is beginning to take a hold on public perception of the field of archaeology. To explore this influence further, this paper summarizes the origins and thoughts presented within popular pseudoarchaeology, current public understanding of archaeology, and why this matters to archaeologists. This paper primarily considers how archaeology is portrayed in Canada and the United States, although I use additional international examples to underscore the importance of global public engagement and media influences within the field of archaeology. Stressing the lack of accurate representation of archaeology, especially regarding the representation of Indigenous peoples, provides an invitation to strive for public engagement and honest discourse about the field.

Keywords: pseudoarchaeology, public perception, pseudoscience, public engagement, white-supremacy, misinformation

INTRODUCTION

Prior to entering formal education or employment, professional and academic archaeologists usually have a preconceived notion or definition of what archaeology is and what archaeologists do. Often, popularized media in the forms of literature, television, and film offer the first exposure of archaeology to budding archaeologists and non-archaeologists alike. Inaccurate representations of the field are generally the first depictions of archaeologists that many people perceive as truth. While these representations of archaeology can be intended as harmless and romantic portrayals of the field, ultimately, many of them are rooted in colonialist ideologies that perpetuate racist ideas. Due to the inaccuracies and falsities these representations present, archaeologists and other researchers often dismiss believers in pseudotheory. However, with the current rise in scientific distrust and white supremacist groups in North America, exposing the potential harm in pseudoarchaeology and inaccurate archaeological representation in popular media is dire. This article discusses this topic further analysing the origins of popular pseudoarchaeology today, the media representations of archaeology, how the public perceives the field of archaeology, and what this means going forward. In doing so, this article highlights current and past perspectives on archaeology through qualitative survey data

to communicate the discrepancies in public engagement and interest in public opinion from researchers in archeology.

THE EMERGENCE OF PSEUDOARCHAEOLOGICAL THEORY

Pseudoscience and pseudotheory derives from the Greek prefix pseudo, meaning "to lie or to cheat" (Card and Anderson 2016). Essentially this means science or any school of thought that is unfounded by credible evidence or rejects the scientific method altogether. Archaeology, a field built on material evidence from humankind, rejects pseudoscientific or pseudotheory based on its lack of logical explanation that provides information on the human past. Many popular schools of thought in pseudoarcaheology are derived from misinterpretations of historical texts, and many known today are based off ideas presented by the Theosophical Society (Anderson 2019)

The Theosophical Society was founded in New York City in 1875 and included a group of spiritualistic seekers. Theosophy is the intent of achieving knowledge of God through spiritual ecstasy or connecting with otherworldly or supernatural beings (Anderson 2019). Notable names in this group include Helena Blavatsky, Henry Olcott, William Judge, and George Felt. The group believed in powerful ancient beings, supernatural powers of humankind, and these powers within the natural world (Anderson 2019; Card and Anderson 2016). Blavatsky is responsible for many of the popularized forms of pseudoarchaeology seen today. Most notably, she wrote about the five Root Races, or stages in the development of humanity. In the Fourth Root Race, Blavlatsky's writing claimed that humanity went through a stage of emotional development, which occurred on the lost continent of Atlantis (Anderson 2019). While Blavatsky made these claims, Atlantis had only recently been brought back to public attention with a publication by Ignatius Donnelly, sparking the discussion on the existence of Atlantis. Donnelly presented the Atlantis theory as hyperdiffusionist, a common theme in many pseudoarchaeological claims in which the cultures of ancient Egypt and the Maya were so great that they must have a common origin (Feder 2006). Hyperdiffusionism suggests that two or more cultures are of a single origin, often rejecting cultural diversity of the past (Anderson 2019).

Another theosophical claim that sparked popular texts are derived from Howard Phillips (H.P.) Lovecraft's (years active 1917–1937) and Erich von Daniken's (born 1935) Ancient Astronaut theory, otherwise known as Ancient Aliens. Von Daniken suggested that the primary influence for his Ancient Astronaut theory were the Vedic texts of India, which described temples that could fly through the sky and into the darkness (Anderson, 2019). At the same time, Blavlatsky also alluded to a similar theory with reference to the alleged ancient Tibetan text named The Book of Dzyan. With reference to The Book of Dyzan, Blavlatsky suggested that otherworldly beings led and aided the people of Atlantis to take the first steps in building society as we know it today (Anderson, 2019). Lovecraft, popular pulp fiction author, used these theosophical ideas within his writings. Many people who are familiar with Lovecraft's writings read them as truth rather than simply fiction (Card and Anderson, 2016) Von Daniken also used the theosophical claims to support the Ancient Astronaut theory (Card and Anderson, 2016).

As absurd as these theories may seem, they are often cited as spiritual or religious belief and explanation for natural phenomena outside of Western Science (Feder, 2006). More often though, the satisfaction obtained from pseudoarchaeological discourse seems to lie in a rebellion against the authority of scientific rationalization. Mainstream archaeology has become a major purveyor of damaging the mysticism of pseudoarchaeology in the sense that mainstream representations pushes the historical record back further, denuding the

past of mysterious forces, and dispelling the enchantment of ancient sites (Laycock, 2019). Some of these theoretical approaches, whether rooted in religion or not, can however, have serious consequences when tied with colonialism and racist ideologies.

POPULAR MEDIA REPRESENTATIONS OF ARCHAEOLOGY

Film and Television

The general public may hear about the field within popularized media such as Indiana Jones, representations of Atlantis, or TV shows such as Ancient Aliens. These examples provide a glamorized or false idea of what archaeological studies and practices are. Despite this, many consumers gain an alternative perception to what archaeologists do and what archaeology is as a field. Often, archaeologists immediately dismiss these ideas without considering the origin of them, or the influence they may have on the general public.

While having little to no basis, the Ancient Astronaut theory, popularized by von Daniken's Chariots of the Gods, has one of the largest influences on popular media including pseudoarchaeology. This theory is also found in Hollywood science fiction films. Like Atlantis, Ancient Astronaut theory endorses diffusionism, in which similarities in material culture through space and time exist only due to one influence or one type of being (Card and Anderson, 2016). As previously mentioned, many of these media portrayals of archaeology in Hollywood have theosophical influences such as the TV show, Ancient Aliens (2009–present). Many other popular films have likewise featured archaeologists engaged with paranormal monsters or powerful ritual objects, most prominently the Indiana Jones film franchise (1981–present). The plot of each film revolves around a particular artifact imbued with spiritual power. The first and third films, for instance, focus on the Ark of the Covenant and the Holy Grail respectively, which are sacred objects from Jewish and Christian tradition (Anderson, 2019). The fourth film similarly relies on a crystal skull as its primary plot device. Through the film, this skull is shown to have miraculous psychic abilities, and, at the end, is shown to be the actual skull of an extraterrestrial being.

The film Prometheus (2012) presents another hyperdiffusionist perspective of ancient cultures, assumed to be endorsed by real life archaeologists. The plot of this film is set in 2089 CE, in a cave on the Isle of Skye in Scotland. The introductory characters, archaeologists, discover a collection of 35,000-year-old cave paintings. In one of these paintings an anthropomorphic figure is pointing with its finger to a group of six circles. The archaeologists present their findings at a meeting, and, in a typical pseudoarchaeological manner, they connect the representation from the cave on the Isle of Skye in Scotland with later representations from different cultures all over the world. They supposedly found the same representation of six circles on an Egyptian papyrus from 2470 BCE, a Mayan stela from 620 CE and on a Sumerian monument from the beginning of the third millennium BCE (Matić and Žakula, 2021). There is both a supernatural and hyperdiffusionist representation within the film, portraying inaccurate representations of archaeology and of history.

Inaccurate portrayals of the field are more easily consumed than accurate portrayals of archaeologists. In understanding these portrayals of pseudoarchaeological thought, it is easy to assume that Hollywood makes films for entertainment and profit, not primarily to convey some sense of historical events. Consequently, movies typically embody contemporary stereotypes and mythologies. Hollywood creates films that audiences see as both familiar and consistent with trends in popular media. In cinemas this process situates archaeological activities in supernatural

worlds, and hence a consumer can grasp meaning by analyzing the mystical qualities or themes visible on screen due to powerful imagery of supernatural relationships with the past (Hiscock, 2012). Filmmakers can be considered producers as well as consumers of pseudoarchaeological thought.

The goal of cinematography in science-fiction or action and adventure film is often to make events appear realistic. Cinema audiences receive visually powerful fictionalized narratives that subtly and forcefully deliver stories that offer the same image of the human past as stories offered in the guise of pseudoarchaeological research (Hiscock, 2012). These movies have the capacity to deliver ideas about the human past without having to persuade the audience to accept evidence. This provides further reason and meaning for an audience to be incredibly receptive of pseudoarchaeological thought (Hiscock, 2012).

Journalism and Social Media

There are many other ways media portrayal may influence public opinion of the field of archaeology. However, there have been few analyses conducted on media portrayal of archaeological work from news outlets and social media. When thinking of archaeology, many of those outside the field may think of academia as a primary career for those pursuing the field. However, cultural resource management (CRM), is the largest employer of archaeologists around the world. CRM may employ archaeologists through private, public, or government sectors to manage sites at risk from development or natural forces and preserve archaeological and heritage resources. Canadian governmental policy often requires CRM to be conducted before undergoing any major development project (Kuhn, 2002; Pokotylo, 2018). Because this is a major avenue for many archaeologists to be employed, CRM requires funding to ensure that archaeological resources are protected and therefore public interest is engaged.

Robert Kuhn (2002) examines CRM portrayed in media in the state of New York, USA. While this article does not solely focus on public perception, the paper focuses on how press coverage can influence public perception of archaeology. If public perception is negative, archaeological work may receive little to no funding from government organizations and private funding avenues. Kuhn's review consisted of over 200 media coverage samples from newspapers on CRM. The newspaper clippings fell into three categories: archaeology focused (discoveries, information about the past, or opportunities to see new sites), development projects regarding the status of archaeological work, or issues and procedures in CRM (Kuhn, 2002). During the given time period, 1,965 projects were conducted in the state and only 53 were reported on. 20% of quotes are from CRM professionals. 29% of quotes outside of CRM are from other professionals in the field of archaeology, knowledgeable about archaeology, or are in favour of CRM. 10.6% of all newspapers contained one or more errors, including dates of sites, spelling, or terminology errors. One in every ten articles contain misinformation about archaeology or a CRM project. 25% of all articles have a negative stance on CRM projects, where 32% of articles are deemed positive representations of the field. All editorials and commentary focused on controversies in CRM. Media representations on CRM and archaeology vary from location to location. While much of the representation is positive, there is still significant amounts of room to improve in journalism. With limited resources such as tight deadlines or lack of resources, journalists may have considerable obstacles when reporting on projects (Kuhn, 2002). Even so, their position to report on CRM greatly shapes how the public views archaeology. Considerations for the field could be to

generate a greater network of individuals outside CRM projects for media outlets to contact who may reflect a meaningful view of a project such as academics, those who work in heritage branches, Indigenous stakeholders, and so on.

The development of social media has been instrumental in spreading information from journalists and scientific journals. Often, information can be skewed and misinterpreted, even when regarding sensitive issues. In recent years, the National Centre for Truth and Reconciliation (NCTR) has been working closely with Indigenous communities in aiding and collecting statements from survivors and their families of Canadian Residential Schools. Canadian Residential Schools were part of a larger initiative beginning in the 1880s to exterminate Indigenous cultures and identity by removing children, as young as two or three, from their parents and forcing them into government and church run schools (National Centre for Truth and Reconciliation, 2015). The unfortunate reality of these schools is that school officials made up of Christian church members subjected children to disease, starvation, neglect, physical abuse, emotional abuse, and sexual abuse. Many children died, often without a marked grave (National Centre for Truth and Reconciliation, 2015). In 2021, the Tk̓emlúps te Secwépemc Nation of Kamloops, British Columbia issued a statement regarding the preliminary analysis of Ground Penetrating Radar (GPR) indicating the presence of unmarked graves of 215 children (Tk̓emlúps te Secwépemc Office of the Chief, 2021). This press release generated widespread media attention, which transpired across multiple forms of news access, including social media. The attention was also put towards the ongoing work of Indigenous communities and their collaboration with GPR specialists, including archaeologists (Ka'nhehsí:io Deer, 2021). Unfortunately, social media has also perpetrated the spread of false and misleading information that the graves of 1,100 children were discovered at Blue Quills First Nation, when the First Nation did not issue any statement that this happened (Ka'nhehsí:io Deer, 2021). Misinformation regarding or portraying the sensitive work of current archaeologists in Canada with the NCTR, while inaccurate, can be incredibly harmful to Indigenous communities, survivors, and their families who are working towards healing from this historic trauma.

EXPLORING PUBLIC PERSPECTIVES AND PERCEPTIONS OF ARCHAEOLOGY

After establishing the emergence of pseudoarchaeology and its relation to media representation of archaeology, it is worthwhile to explore studies of how public perception of the field has been reflected. There are currently studies exploring the perceptions of archaeology from individuals pursuing post-secondary education (Gotshalk-Stine 2011), individuals actively engaging in archaeological interest by visiting archaeological sites or museum settings (Kajda et al 2018), and from members of the public (Pokotylo 2002). However, recent survey data is limited and suggests a general lack of interest in pursuing the understanding of public perception of the field. Data that does exist can create a broad, overlaying interpretation of how the public understand the view of archaeology. This section will explore some of these data sets to create a sense of where public perception lies today.

General Public Perception

In Canada, most archaeological sites have a deep connection with descendant Indigenous communities. Therefore, archaeological perceptions of Indigenous peoples are ultimately the most important consideration when archaeology is being practiced. However, there have been very few archeological studies on this matter, except for a general review by Joe Watkins (2005).

While many Indigenous people globally could still hold a similar perception of archaeology over fifteen years later since the publication from Watkins (2005), it is important to note that over the past 50 years, archaeology has shifted dramatically from primarily science-based to being a discipline employing both quantitative and qualitative research (Atalay, 2012). In North America especially, much of the archaeological record is directly tied to Indigenous peoples and their ancestral histories, meaning that archaeology both directly affects Indigenous communities and the future of archaeology. Failing to acknowledge and actively remove colonial practices and attitudes in the field will perpetuate poor relationships with Indigenous communities and archaeologists. As noted by Watkins (2005), relationships between researchers and Indigenous communities in United States are cold due to colonialist attitudes although collaborative efforts vary from state to state (Watkins, 2005). Although Watkins' perspective is positive regarding Canadian archaeological practices, I argue that there is indeed much room for improvement with Indigenous communities across the country and world, and the more recent shift towards reconciliation efforts are a considerable step to acknowledging and improving colonialist practices.

Elsewhere, Sami from Scandinavia, Aboriginal people from Australia, and Maori from New Zealand are becoming increasingly involved with archaeological practices. However, Mesoamerican, and South American archaeologists are mostly in the beginning of the process of forming collaborative efforts in archaeological practices. It is also appropriate to note that the level of community-based initiatives is highly dependent on funding and accessibility (Watkins, 2005). While these perspectives are important to understand for the future of archaeology, continued surveying on Indigenous perspectives and opinions of the field would also be worthwhile to providing insight on improving researcher and community relationships if deemed appropriate. When researching current perspectives on archaeology, it is vital to include the perspectives of descendant communities, who often contain intimate knowledge of archeological sites and historical evidence an outsider would not otherwise know. Archaeology is ultimately a field rooted in colonialist ideas, and failure to recognize this is failure to recognize what strides could be made in active and inclusive engagement with study communities (Atalay, 2012).

Local governments of communities have a large role in protecting archaeological sites from increasing commercial and industrial development. Amanda King's and colleague's study (2011), for example, focuses on the relationships and perceptions of archaeology of municipal councilors and Indigenous councilors in the Fraser Valley. Very few municipalities in the Fraser Valley incorporate the protection of these sites into their policies. A 2011 survey conducted in the Fraser Valley region solely focused on these governments resulted in a 27.9% response rate. From these surveys, data analysis concluded that less than 20% of councilors knew the archaeological inventory of the province and very few municipal counsellors could identify when humans arrived in North America. Indigenous councilors identified the latter question with a qualitative answer, since time immemorial, indicating traditional beliefs. 25% of Indigenous counsellors believed that their own governments developed laws to protect archaeological sites. While both governments were not well informed on archaeology, Indigenous counsellors showed more interest and regarded archaeology as highly relevant to Canadian society (King et al. 2011). Municipal government councilors generally regarded archaeological sites most important to the scientific community. While Indigenous councilors put more emphasis on visiting more pre-contact sites than municipal councilors,

who put more emphasis on visiting historic sites. 67.1% of Indigenous councilors disagreed or strongly disagreed that the provincial government has effectively managed archaeological heritage in the region. A primary theme in this survey is that although some differences in opinions may be minor between Indigenous and municipal councilors, Indigenous councilors offered a different perspective when addressing heritage that may be directly linked as ancestral or solely due to traditional beliefs (King et al, 2011). Many of the First Nations and municipal governments agree that there should be a single, local heritage policy to govern the management of archaeological sites in the region. To do so, communication between local government systems needs to improve to protect and manage the archaeological heritage the participants are concerned with (King et al, 2011).

There have been very few studies conducted with participants Canada-wide regarding perceptions of archaeology in the last decade. The most recent, David Pokotylo's 2002 study focused on participants from all provinces in Canada. The survey involved eighteen multiple choice questions and seven open ended questions. One in five participants identified dinosaurs in association with archaeology. Participants had formal training in post-secondary or secondary education and displayed a wide age range and multiple gender representations. Most participants had a very general or limited sense of what archaeology was as a field, despite 91% stating they visited museums and 41% visiting an archaeological site. Most respondents identified humans living in Canada between less than 500 years to 5,000 years, with most answers (23%) lying between 1,000–5,000 years. 14.7% of participants stated humans have lived in Canada for more than 100,000 years. 37.2% participants identified that there are between 100–1,000 archaeological sites in Canada, with 2.7% identifying the reality that there are over 100,000 (Pokotylo, 2002). Respondents identified that archaeology is most important to the scientific community and Indigenous peoples, and having only some importance to the public and governments. When asked what value archaeological objects have, 70.2% of individuals assigned historic value to archaeological artifacts, with the second largest (24.8%) category being monetary value. Monetary value assignment decreased with increasing age and increased with the amount of formal education individuals had. Participants generally put more emphasis on archaeology aiding in understanding the cultural diversity and history of Canada (Pokotylo, 2002). Generally, those who identified themselves as women, put a higher emphasis on the protection of archaeological sites. In summary, results from this national survey showed that individuals more concerned with archaeology tended to identify as female, be middle-aged or older, and/or have some formal post-secondary training (Pokotylo, 2002).

The survey also revealed very little understanding of the association of archaeology with Indigenous peoples, although some emphasis was placed on conferring with Indigenous peoples on the discovery of human remains. Participants also stated that they received their information on archaeology from television. Due to this survey being conducted almost 20 years ago, this has likely changed as a result of the internet being a major resource, yet likely contains similar problems of representation. Pokotylo (2018) revisited this topic on a regional scale to evaluate public opinion based on qualitative analysis of comments from online news articles. The three articles that hosted online comment discussion concerned the protests for development on Grace Islet, British Columbia. This island is part of a larger pre-contact village site, Shiya'hwt, or the Ganges Harbour village site first recorded in 1966. Subsequent surveys also revealed the

island was home to many shell midden burial sites and cairns containing human remains. In 2014, construction commenced on the island and was met with strong opposition from the Cowichan First Nation, local residents, and other supporters. The Cowichan First Nation filed a claim that granting private ownership of Grace Islet infringed their Aboriginal title. The provincial government halted construction in 2015 and partnered with the Cowichan First Nation and a land conservancy to purchase the islet for $5.45 million CAD (Pokotylo, 2018). Nearly half of the online comments concerning the press coverage of Grace Islet were negative and expressed distrust in the Indigenous locals, the provincial government, and professional archaeologists (Pokotylo, 2018). Pokotylo's (2018) qualitative survey, despite being nearly 20 years later than the 2002 survey previously mentioned, revealed that those who engaged in discussion reflected a continued low level of understanding of archaeology and heritage conservation laws. Those who also engaged in online discussion showed an increased negative attitude towards Indigenous management over archaeological sites and a decreased support of Indigenous rights to use archaeological sites in their cultural practice. This is not representative of a national population, and it would be worthwhile to continue investigating results across the country to understand public perception.

More recent data about public interest in and perception of archaeology comes from the United States. The Society for American Archaeology and Ipsos (2018) collected data on American perception on archaeology between 2017–2018 based on 1,024 participants within the general American public. The poll found that 93% of survey participants view archaeological work as important. In this study, 54% of individuals associated archaeology with dinosaurs. Generally, there is support for archaeology being taught to students at some point in their academic career (87%) (Society for American Archaeology and Ipsos, 2018). According to the survey, the preferred methods of learning about archaeology are in museums, classrooms and textbooks. There is no clear distinction of where the participants are from in the full report, and there may be regional biases.

Archaeology in Europe is incredibly prevalent as a career due to the concentration of archaeological sites within the continent. As such, public perception on archaeology generally differs from North American public perception. Kornelia Kajda et al. (2018) maintains that the 2008 economic crisis may have impacted public perception of academic research due to the decline in funding towards research and relevance of the subject to the public during economic stress. Typically, in times of economic decline, scientific research is not prioritized by the government, leading to a decline in funding and decline of media representation (Kajda et al. 2018). A survey was conducted on members of the general public in Greece, the United Kingdom (UK), France, Spain, Sweden, the Netherlands, and Poland. Participants associated archaeology with digging (excavation) and as a field of science that analyzed the past. Only 26% identified it as a profession (Kajda et al. 2018). Approximately 90% of the 4,516 respondents viewed it as a field with great value and as a useful tool for teaching people about the past. Over 50% of respondents also expressed interest in participating in archaeology, meeting archaeologists, and going to museums where there are archaeological materials. 58% of individuals stated museums pay too little attention to archaeology (Kajda et al. 2018). While there is a positive general sense that the countries involved with this study support archaeology, responses differ from country to country. Individuals from Greece and Italy generally view archaeology as important, likely because archaeological research invites tourism to the country as an economic resource. In Sweden, interest and participation is lower among young people and those of

lower economic status. Poland views archaeology as most important for education and is integrated into teaching the history of Poland. In the UK however, only 26% of respondents viewed archaeology as important for understanding the past. In Spain, more respondents placed emphasis on the protection of resources than the education on archaeological sites (Kajda et al. 2018).

Amy Gotshalk-Stine's 2011 study has explored the presence of misconceptions and media influence on how the public understands archaeology. In public surveys, researchers can come across misconceptions about what archaeologists do, as seen in many of the recent studies featured in this paper. Misconceptions often include a romanticized idea of an archaeologist influenced by fictional characters such as Indiana Jones or Lara Croft, or that archaeologists only dig for dinosaurs or conduct geological research. Another misconception that the public has on archaeology, even within the field, is that this is a male dominated field when, in reality, the opposite is true. In Gotshalk-Stine' thesis (2011), first year geology and anthropology students were asked to draw an archaeologist on the first day of class. One study included a test called a DART (Draw a Researcher test) and is used to test implicit bias of gender stereotypes in the sciences. After the emergence of female scientists from popular television shows such as CSI, female scientists became a more common theme in these tests, emphasizing representation in popular media as an important influence (Gotshalk-Stine, 2011).

Following the DART test, the university students were asked to answer questions on their perception of archaeology. The answers were used, and the pictures were coded to find similar themes of how students and the public perceive archaeology. Students often presented a Lead Researcher or scientist, indicating that they perceive archaeology to be a team related science (Gotshalk-Stine, 2011). Men were represented by characteristics classified by the author or pronouns more often than women. Digging, researching, or looking for artifacts was a common theme in the drawings as actions of the archaeologists, which presents a generally accurate representation of excavation. Most (91%) identified an outdoor setting for the workplace of archaeologists, with laboratory settings being presented less often (6%). Digging tools were also dominantly presented, along with recording devices such as books and cameras, field clothing (cargo pants, hats), GPR, flashlights and other accurate tools researchers may use. While some of these representations are accurate, 40% of students still mentioned dinosaurs in some form such as a fossil. Only 35% of the drawings contained what the Gotshalk-Stine (2011) labels as an accurate depiction of archaeology. When asked what sources of information were the most important on archaeology, the respondents listed museums, documentary television and movies as their top three choices (Gotshalk-Stine, 2011). While there is some awareness of accurate archaeological practices, all three misconceptions mentioned were represented in many of the drawings (Gotshalk-Stine, 2011). Like many of the studies mentioned in this paper, there is a basic understanding of archaeology with plenty of misconception. In saying this, there is likely room for perceiving pseudoarchaeology as possible "reality." Minimal understanding of the field and reduced access to education about archaeology allows the public to become perceptive to false representations in accessible media. This can be especially problematic if media representations of archaeology present information from a colonialist standpoint. Inaccessibility to accurate information creates opportunity for pseudoarchaeological theory to propose ideas to the public that would otherwise be rejected by archaeologists and descendant communities

CONSEQUENTIAL IGNORANCE: THE RISE OF WHITE SUPREMACY AND SCIENTIFIC DISTRUST

Since the outbreak of the 2020 SARS-CoV-2 virus (commonly known as COVID-19), misinformation has become more mainstream on social media platforms, especially regarding public health measures such as vaccinations and masking. In the Reuter's 2020 Digital News Report, Facebook was seen as the main channel for spreading false information but also consistently one of the top forms of receiving information about the pandemic and world news for the public (Newman et al. 2020). Even so, the results of this study also found a rise in conspiracy theories and pseudotheories on social media platforms (Newman et al. 2020). Due to the continued prevalence of these applications, this is still an ongoing issue in many fields, including archaeology as seen with pseudoarchaeology.

As viewed in the studies presented in the previous section, many people have a minimal to very basic understanding of archaeology and there is plenty of room for engagement. Popular media can, however, introduce pseudoarchaeological theory to members of the public who otherwise do not have accessibility to or the desire for formal education in archaeology. There have been many commentaries on why false histories and imagined pasts have appeal. It is worth noting that not all history transforms into popular narrative. A possible appeal of pseudoarchaeology is the apparent certainty and simplicity in theory. Archaeology can take years to form a viable explanation for a phenomenon with no absolute certainty, but there is attraction in a writer who creates an apparently simple explanation for complex phenomenon by suggesting that aliens are a reason, or perhaps Europeans were the first in North America (Derricourt, 2012; Feder, 2006). These theories are often formed with motive, perhaps based on prejudice and racism. Pseudoarchaeological theory also contain huge claims, selective or distorted presentation, selection of evidence from a wide range of different fields, and vague definitions of complex concepts or terminology (Derricourt, 2012). Despite the false and problematic viewpoints of these theories, pseudoarchaeological thought still resonates with members of the public. This may be largely due to integration of pseduoarchaeology into popular media presentations of the field. David Anderson discusses in a 2019 paper that in 2018, 57% of American survey participants responded that they "Agreed" or "Strongly Agreed" with the statement that ancient, advanced civilizations, such as Atlantis, once existed. While 41% of respondents supported claims of ancient alien contact.

While most archaeologists view these theories as completely absurd and lacking scientific validity, pseudotheory can contribute to dangerous ideologies such as widespread white supremacy. For example, narratives such as the Ancient Astronaut theory, while seeming harmless, removes autonomy from non-white and Indigenous archaeological histories. Narratives that remove this autonomy completely disregard the research of scientists and scholars attempting to understand human cultures in the past and present, human evolution, and the development of society to today. Perhaps unintentional, these theories are proposed in favor of a problematic and colonialist origin story, deeply rooted in racist narratives of "great civilizers," bringing knowledge and technology to the "unenlightened savages" (Matić and Žakula, 2021). None of the structures on Ancient Aliens were built by non-white or Indigenous peoples in favour of a racist and colonialist narrative (Card and Anderson, 2016; Anderson, 2019). What many of these theories fail to recognize is that similar human experience and thought can exist independently across time and space, and

without influence from otherworldly beings. Moreover, these theories actively dismiss and omit Indigenous archeological sites and world wonders such as Pueblo cities, the Newark Earthworks, Cahokia, among many others.

Additional racism can be found in the creators of such theories. Atlantis, another example, is said to have been the origin of a "Master Race." Archeologist Frank Joseph (born 1944), also known as Frank Collin, is cited for many of his works on the existence of Atlantis. Most of these works suggest that the Atlanteans were a Master Race of Aryan blood, and brought forth advanced writings, inventions, and technologies (Kaplan, 1997). Joseph was also a convicted pedophile and was a member of the American Nazi Party (Kaplan, 1997). To ignore this is to simply disregard the underlying issues with supporting biased pseudoarchaeological theory. Presentation of pseudoarchaeological theories may also gloss over the figures that popularize pseudoscientific theories such as Joseph and their history, leaving the public unaware of the entire context behind pseudotheory.

Presented in popular media like television is the support of a theory that promotes a European First model in the peopling of the Americas. The Solutrean hypothesis, which archaeologists have widely rejected, proposes people from the Solutrean culture of southwestern Europe were the first to settle on the east coast of North America between 17,000 and 20,000 years ago. It is often proposed that these people would have been white (Raff, 2018). The theory, popularized and supported by two prolific archaeologists Dennis Stanford and Bruce Bradley, form most of this theory based off a similar projectile point style in Northeastern United States (Stanford and Bradley, 2012). Their argument contains little to no reputable environmental evidence that a land bridge occurred between Europe and North America 20,000 years ago, and little to no evidence of similar genetics between Solutrean people and Indigenous groups. There is also no other defining archaeological evidence to support this claim, other than a diffusionist perspective. Clovis-first and coastal migration site dates in Alaska, Yukon, and British Columbia challenge the dates proposed by the Solutrean hypothesis (Raff, 2018). Although there is little evidence to support the Solutrean hypothesis, this theory is often used to support white nationalist groups that claim Europeans arrived first in attempt to assert white connections to North American lands over Indigenous ones (Raff, 2018).

Due to the positionality of such racist pseudotheory as explanations for the origins and history of humans, it is no coincidence that they are used to support modern white supremacist agendas. According to a 2019 report from the Southern Poverty Law Center, the number of white nationalist hate groups in the United States increased by 55% between 2017 and 2019. Social media and the internet have helped extremists extend the reach of racist ideologies and conspiracy theories (California State University, 2019). White supremacists, in fact, are increasingly congregating online, often not formally joining hate groups but networking, raising funds, recruiting and spreading propaganda that radicalizes young people and stokes violence against immigrants, Jews, Muslims, Black people, Indigenous peoples, and other minority groups (California State University, 2019). As absurd as some theories may be, their problematic stances and uses can be incredibly dangerous.

One issue that creates a barrier between the relationship of researchers and the public is inaccessibility to peer-reviewed information, access to misinformation, and barriers to researchers attempting to understand how to improve communication between researchers and the public. For example, social media platforms such as Twitter, Facebook, and Instagram are widely used as a source of information on various scientific thought.

However, data that allows social researchers to understand public perception on such platforms are often effectively inaccessible to the average researcher. The year 2018 marked the beginning of the end of easily accessible data on social media engagement—at least, for the poorly resourced scholar, or the researcher without a relationship with a proprietary platform, or one funded by government or other large organisations (Richardson, 2019). Application Programming Interfaces (APIs) of social media platforms provided access to social science data for researchers. However, Facebook and Instagram limited access to public APIs and Twitter has offered premium paid access to its data at a price usually beyond what research funding can allocate (Richardson, 2019). As long as there is a boundary between researchers conducting both qualitative and quantitative analysis on information spread through popular platforms, there is little room to build on the understanding of how misinformation spreads on social media. If researchers are going to better understand public perception of their respective fields and attempt to prevent the online spread of misinformation, then data on social media engagement must be made accessible if it remains a primary form of communicating pseudotheory. If misinformation is more accessible than peer-reviewed data for both researchers and the public, then there will be a stronger reliance on dishonest science and distrust in candid research.

Anderson (2019) notes that many of those who engage in pseudoarchaeological thought are engaged and interested in exploring traditional archaeology if researchers are not immediately dismissive. All accounts are not equally valid or legitimate. Certain viewpoints which some of us may feel compelled to refute and dismiss others will see a strong need to respect and defend, each reaction based on specific values and personal choices. However, there is an extremely fine line between alternative belief and religious or spiritual explanations for the past (Holtorf, 2005). For evaluating different versions of the past and their impact it is essential to understand the local contexts which they reflect and originate. Similarly, when conflicting interpretations directly compete, all local sensitivities need to be carefully studied and pragmatic solutions found that allow peaceful coexistence. Critical understanding and dialogue, not dismissive polemics, is the appropriate way to engage with the multiple pasts and alternative archaeologies in contemporary society. Committed and informed dialogue brings about mutual appreciation and the possibility of working together in studying past remains and rendering landscapes meaningful (Holtorf, 2005). If the world has learned anything from the recent COVID-19 pandemic and resistance to information in a dire time, it is education and not dismissal of belief that ultimately benefits everyone

CONCLUSION

Considering the ideas presented within pseudotheory and pseudoarchaeology, it can be easy to be dismissive instead of engaging with those who perpetrate these false ideas. However, with the lack of research in exploring public perceptions of archaeology, the lack of understanding of the field, and the barriers for the public to accessing accurate information, it enhances opportunities for individuals to believe misinformation. As seen with the rise of white supremacy, this can be inherently dangerous. While this paper aims to both draw attention to this issue and explain the relevance of pseudoarchaeology to archaeologists, it also invites people to resist ignorance when found, and to opt for engagement and honest conversations about the field with the public. Science, from any standpoint, is the process of learning about and making sense of the universe, not the process of dismissing ideas and people who may not

understand or accept an explanation.

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REVIEW ARTICLE

Using Metaphors of Contagion: How Framing Obesity as 'Epidemic' Shapes Cultural and Medical Understandings of Noncommunicability and 'Fatness'

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ABSTRACT
This paper explores the contentions regarding the use of the term 'epidemic' in obesity discourses. Obesity studies are increasingly demonstrating links that suggest that the condition is communicable, thus possibly warranting an 'epidemic' framework. On the other side–to which I position this paper–obesity remains understood as noncommunicable. Therefore, when the notion of 'epidemic' is employed, it is recognized as metaphorical. Drawing on the works of critical scholars, this paper argues that this metaphorical framing of obesity as 'epidemic' has more harmful consequences on prevailing cultural and medical understandings of fatness, such as an increase in biopower and Othering.

Keywords: medical anthropology, obesity, metaphors of contagion, epidemic, noncommunicability, biosociality, biopower, foodways

INTRODUCTION

According to many major medical organizations, such as the World Health Organization (WHO) (2021b) and Centers for Disease Control and Prevention (2021), obesity is classified as a noncommunicable disease characterized by an 'abnormal' or 'excessive' accumulation of fat that exhibits a risk to health. The global prevalence of obesity has grown exponentially in the past forty years. The most recent estimates suggest that approximately thirteen percent of the world's population were obese in 2016 (WHO 2021b). Notably, obesity has crossed traditional geographic, cultural, economic, gender, and age barriers, now affecting a wider range of individuals, families, and communities all over the world (Aguirre 2009). As a result, the condition has come to be invariably referred to as 'epidemic.'

Since its use by Hippocrates in fifth century B.C., the term 'epidemic' has largely been used in respect to infectious, or communicable, diseases (Martin and Martin-Grenel 2006). Beginning in the second half of the twentieth century, however, 'epidemic' has also been used in reference to non-infectious, or noncommunicable, diseases, such as cancer and obesity, as well as suicide and violence against women (Martin and Martin-Grenel 2006). These metaphoric uses of 'epidemic' have attracted several critiques from scholars who argue that framing such phenomena, notably obesity, using terms associated with contagion could have unintended detrimental effects. Whereas many biomedical professionals and institutions argue that their use of 'epidemic' of obesity is warranted given the condition's rising prevalence and possible molecular etiologies (Moffat 2010). Drawing on these two perspectives and the contestation

of the divide between communicable and noncommunicable diseases, this paper will explore how discourses using the notion of 'epidemic' to frame obesity influence the larger medical and cultural definitions of the phenomenon. Ultimately, this paper argues against the use of 'epidemic' in obesity discourses, as the foreseeable risks, such as an increasement in biopower, and a political and cultural Otherization, outweigh any of the etiological, medical, or scientific benefits.

USING THE CONCEPT OF BIOSOCIALITY IN THE DISCERNMENT OF 'COMMUNICABILITY' VERSUS 'NONCOMMUNICABILITY'

To understand the contention of the use of 'epidemic' when discussing noncommunicable diseases and social phenomena, it is important to understand the ways in which the divide between what constitutes noncommunicability versus communicability is contested. The WHO (2021a) defines noncommunicable diseases as being chronic conditions, which are nontransmissible. That is, noncommunicable diseases are long-term conditions of illness and are not caused by an infection, or other pathogenic vectors, which then cannot be spread person to person. This distinguishment, however, is not as clear and straightforward as it might first appear.

Anthropologists Jens Seeberg and Lottie Meinert suggest that the traditional distinction between communicable and noncommunicable diseases is "intrinsically linked to different forms of biosociality and ideas about causation and lifestyle" (2015, 55). Biosociality, as proposed by Paul Rabinow (2010) in their analysis of biopolitics and emerging biotechnologies of genetics, refers to the ways in which diagnoses of, and genetic predispositions to, illness and disease come to shape individuals' self-identity. In addition, biosociality also refers to the formation of community and kinship bonds with others experiencing the same, or similar illness and disease (Rabinow 2010). Biosociality in communicable diseases, for instance, has been largely found in "global treatment regimes" that identify "potential and actual patients and their relatives" (Seeberg and Meinert 2015, 56). In other words, as bacteria, viruses, and vectors are discovered, those perceived to be at-risk of contracting and spreading the disease are identified and labelled as 'patient' or 'potential patient.' Biosociality in noncommunicable diseases, on the other hand, has mostly been grounded in the "healthy lifestyle regime" that identifies, and seeks to regulate, 'risky' behaviours such as smoking, drinking, poor diet, and physical inactivity (Seeberg and Meinert 2015, 56).

Common forms of biosociality appear in both communicable diseases (e.g., HIV) and noncommunicable diseases (e.g., obesity) as specific risk groups and 'risky' behaviour practices are identified. An example of the formation of biosociality within experiences of disease can be found in Rebecca Marsland's (2012) ethnography of HIV in Tanzania, where clinics are spaces for people interact and form intimate relationships with one another. Like the findings of Marsland (2012), some studies have shown that biosociality in obesity can be understood through the formation of peer-led bariatric groups (e.g., Meleo-Erwin 2020). Furthermore, making use of Ervin Goffman's (1963) notion of a 'spoiled identity,' several studies have also noted how a positive HIV diagnosis may result in an internalization of the associated stigma of the disease (e.g., Frye et al. 2009; Tsarenko and Polonsky 2011). Internalized stigma is also widely observed in people who receive formal and informal diagnoses of obesity (see Moffat 2010; Bombak 2014; Yates-Doerr 2018). In this regard, studying forms of biosociality can demonstrate how the difference between communicable and noncommunicable disease is illusive.

Like the forms of biosociality, ideas about causation and lifestyle continually overlap between the divide of communicable and noncommunicable diseases. Some animal research illustrates this overlap as infections with human adenovirus is being associated with the onset of obesity (Dhurandhar 2001; Singer 2015, 212). As medical anthropologist Merrill Singer summarizes, "approximately 30 percent of obese adults suffer adenovirus infection" (2012, 212). Others have also found an association with gut microbiota and obesity through studies of fecal microbiota transplants (Finlay 2020). Since medical professionals cannot attribute all cases of obesity to microbial pathogenesis, some scholars have argued that 'risky' behaviour, such as poor diet and physical inactivity should also be considered vectors for disease and qualify to be included in the global treatment regime (Ackland, Choi, and Puska 2003; Allen 2017).

Most notably, social scientists Nicholas Christakis and James Fowler (2007) conducted a longitudinal study of approximately 12,000 participants, theorizing that obesity, among other risky behaviours such as smoking, could be spread through social relationships. Christakis and Fowler (2007) proposed that an individual's risk of becoming obese increased depending on their perceived relationships, the type of relationship, and the sex of each person. In their research, Christakis and Fowler found that an individual who perceived someone else to be their friend was fifty-seven percent more likely to become obese if the other person became obese, compared to a 171% increase if both individuals perceived one another to be their friend (2007, 376). Extrapolating these findings, other scholars suggest that 'risky' behaviours or vectors for disease, such as poor diet and physical inactivity, are passed on through family and community relationships, constituting a central characteristic of contagion (Ackland, Choi, and Puska 2003; Huang et al. 2016). Furthermore, the management of communicable diseases has also utilized the healthy lifestyle regime, as stigmatizing 'risky' behaviours have long been identified with diseases such as HIV, including intravenous drug use and homosexual sex. These examples demonstrate that the traditional distinction between communicable disease and noncommunicable disease, on the basis of molecular infection versus lifestyle causation, is not clear-cut.

THE METAPHORICAL USE OF 'EPIDEMIC': THE ROLES OF BIOPOWER, BIOCITIZENSHIP, AND MEDICALIZATION

Despite the possible etiological origins and 'contagious' characteristics of obesity, most biomedical professionals recognize that the framing of obesity as communicable and 'epidemic' is metaphorical (Moffat 2010). This metaphorical use is one in which critical scholars continue to forewarn about, as there are foreseeable negative effects of such a categorization. According to Tyler Tate (2020), metaphors permeate medical language. In fact, Tate maintains that "clinicians and patients seem incapable of speaking at all without recourse to metaphor" (2020, 22). This is the direct opposite to what Susan Sontag claimed was the most truthful way to think about disease; "one most purified of, most resistant to, metaphoric thinking" (1978, 3). Even though metaphors are indispensable figures of speech, since they can help us conceptualize, organize, and understand experiences, they can equally objectify, confuse, deceive, and offend (Tate 2020, 22–23). Specifically, the metaphorical use of 'epidemic' can encourage an understanding of the seriousness with which a condition or phenomenon should be addressed. At the same time, however, the metaphorical use of 'epidemic' often connotes that such a condition or phenomenon is contagious, or easily spread from person to person. Conveyed in the works of Tim Brown (2014), and

Seeberg and Meinert (2015), the notion of contagion holds anxieties of individual morality, social responsibility, and collective action, which can have an 'Othering' effect. Put differently, framing obesity as epidemic and contagious can exacerbate the stigma and discrimination individuals experiencing obesity face and internalize. Therefore, Brown calls for "care to be taken when choosing metaphors used to describe complex social phenomena" lest we perpetrate pejorative ideas (2014, 127).

To understand how framing obesity as 'communicable' and 'epidemic' influence medical and cultural perceptions of the condition, it is beneficial to consider both the possible positive and negative effects. If obesity is understood to be communicable and largely out of the control of the individual, rather than a lifestyle disease, then insurance companies might be more likely to insure treating obesity (Moffat 2010). In the United States, for instance, there are two primary insurance companies that are governmentally funded: Medicare and Medicaid (Mylona et al. 2020). Medicare, being federally funded, supplies health insurance to those over the age of sixty-five and to those under the age of sixty-five who have a disability (Mylona et al. 2020). While Medicaid, which is co-funded by the state and federal governments, provides coverage to individuals with low incomes (Mylona et al. 2020). As one American study showed, "the aggregate medical costs of obesity are estimated to be more than $200 billion annually, and Medicare and Medicaid pay for nearly half of the direct medical costs of obesity" (Mylona et al. 2020, 1). Nevertheless, large numbers of citizens remain uninsured or underinsured by these programs (Martinez-Hume et al. 2017). For example, ethnic minorities and marginalized genders are often situated at the point of convergence between those who are most impacted by obesity, and those who experience structural inequity in healthcare (Aguirre 2009; Greenhalgh and Carney 2014). Commenting on the impact of poverty, Patricia Aguirre argues that "obesity has now been displaced toward low-income population groups, which includes the majority of women and children below the poverty line" (2009, 106). With the new framing of obesity as 'communicable' and 'epidemic,' access to care and treatment might increase for these 'at-risk' populations. Arguably, however, structural inequity is likely to persist despite this new framing of obesity.

At the same time, this new framing of obesity as 'communicable' will warrant an increase in medicalization and government intervention in the form of biopower. Introduced by Michel Foucault (1978), biopower pertains to the regulation and 'optimization' of human populations and bodies by the nation-state. Among many other critical scholars, social scientists Jan Wright and Valerie Harwood have contended that "the naming of obesity as a disease, and the identification of specific risk factors provides the impetus for the close monitoring of those who might be at risk in the name of prevention, and the assumed need for treatment of those who fall within the medically defined categories of overweight or obese" (2009, 3). That is, categorizing obesity as 'epidemic,' and thus a threat to public health, prompts governmental authority to name, monitor, and control risk factors and groups in their attempt to avoid hazard. This becomes especially dangerous when we recognize that vulnerable populations are those in which obesity is most prevalent. As observed in their analysis of obesity among Latin Americans, Susan Greenhalgh and Megan Carney (2014) conclude that the call to take political action against obesity is, at the same time, a call to take political action against ethnic minorities, marginalized genders, and cultural differences. Furthermore, Greenhalgh and Carney make point of how prevailing gendered norms situate women and mothers as being centrally

responsible for health and appearance within the family including obesity (2014, 269). Therefore, as it has been suggested, an 'epidemic' framing of obesity may contribute to the harsh censure directed at ethnic minorities and marginalized genders, who are perceived as impeding public health and causing increased occurrences of obesity.

While obesity is framed as 'epidemic' and governance increases in response, those cultural differences related to food and eating are increasingly vulnerable to discrimination and political action. Scholars overwhelmingly agree that culture influences foodways and obesity, such as cultural differences in understandings of what, where, when, and how much to eat (see Aguirre 2009; Singer 2015; Grøn 2017). In contrast, some scholars argue that viewing obesity as a problem or ignorance of culture can lead to inadequate care and possibly reduce the condition to a culture-bound syndrome (Moffat 2010; Greenhalgh and Carney 2014; Yates-Doerr 2018). Lone Grøn (2017), in their ethnography of obesity among Danish families, demonstrates that the prevalence of this disease is more complicated than a simple attribution to foodways. By focusing on the Danish concept of hygge, or the practice of "socializing through the sharing of food and drink," Grøn points out that not all of those who participate in excessive eating and hygge become obese (2017, 188). An important consideration Grøn makes, however, is that hygge is not simply limited to special occasions, but rather can be a central aspect of everyday life (2017, 189). Therefore, professionals and academics need to be careful about framing obesity as 'epidemic' or 'communicable,' as such integral cultural practices, like the Danish hygge, may be subject to governmental regulation and control.

In a related study, social scientists Greenhalgh and Carney (2014) use the notion of 'biocitizenship' to illustrate the ways in which Latin Americans are, to a broad extent, being faulted for presumed cultural differences. Ideal biocitizens, Greenhalgh and Carney explain, are defined as those who "devote large amounts of time to dieting and exercising in order to maintain a medically 'normal' weight" (2014, 269). This notion of medically 'normal' weight, however, is based on the body mass index (BMI), which has been critiqued as an inappropriate screening tool for health (Halse 2009; Rosen 2014). Christine Halse outlines one of these critiques: "[BMI] is premised on the assumption that there is an identifiable 'normal' weight that is 'true' across genders and across different cultural, socio-economic and geographical groups. Yet even scientific experts who advocate the use of BMI as an epidemiological tool concede that it is an 'arbitrary' measure" (2009, 47). Furthermore, medical doctor Howard Rosen notes that the BMI is not an ideal tool of measurement because it does not account for variations in body composition, such as skin fold thickness (2014, 105). Nevertheless, the BMI continues to be the standard to define 'normal' bodies, weight, and health, as well as how biocitizenship is benchmarked.

Categorized as 'bad' biocitizens by government, media, and peers, ethnic minorities are being represented as having "limited knowledge about healthful eating and exercising" (Greenhalgh and Carney 2014, 268). In other words, non-Western groups, or Latin Americans in the case of Greenhalgh and Carney's (2014) ethnography, are presumed to be ignorant to biomedical information about health and the human body, suggesting they simply do not know any better (Greenhalgh and Carney 2014). However, Greenhalgh and Carney (2014) demonstrate that these populations are not ignorant, but rather, they are entangled in complex social, political, and economic structures (i.e., job security, unaffordable housing, structural violence, domestic abuse, etc.), that act as barriers and prevent them from being 'good' biocitizens. In fact, some ethnographers have argued that

policy makers and health educators are ignorant for not understanding the diverse ways in which health and foodways are valued (Sanabria 2016; Yates-Doerr 2018). This ignorance was demonstrated in a speech at the 2013 annual conference of the National Council of La Raza (NCLR), where former First Lady Michelle Obama placed individual responsibility on the Latin communities for not owning or questioning their dietary beliefs and practices (Greenhalgh and Carney 2014, 268). It is important to emphasize again, as Emily Yates-Doerr reminds us, that there is no cross-cultural "consensus that fatness is unhealthy," and we cannot assume otherwise (2018, 109).

As a result of increased intervention, the 'epidemic' framing of obesity has also led to an increase in funding for medical research, particularly for the studying of potential pharmaceutical applications (Moffat 2010). While this could lead to tremendous treatment options, some contend that this is yet another "parcel of a wider capitalistic health care system" (Moffat 2010, 8). For instance, Moffat claims that "there is a profit to be made from bariatric surgery for adults and clinics and camps to treat obese children" (2010, 8). This assertion stems from the wider critique of the 'epidemic' framework for public health policies and measures. As it has been demonstrated, the rising prevalence of obesity should be situated as resulting from larger societal, political, and economic structures. Despite the 'epidemic' framework of obesity, anthropologist Emilia Sanabria proposes that "the epistemic regimes that dominate the field of public health … frame complex problems in a manner that reduces them to what is manageable, even when such framings are contested or shown to be inadequate" (2016, 135). As such, many public health approaches continue to present obesity as the responsibility of the individual and family (Moffat 2010; Greenhalgh and Carney 2014).

CONCLUSION

There is no consensus on whether obesity is noncommunicable or communicable, as these concepts are continually being contested. Traditionally, noncommunicable diseases are distinguished as being nontransmissible, chronic conditions. As with the case of obesity, however, this distinction is deceptive as scholars and medical professionals continue to discover and argue the condition's communicability. Regardless of its literal or metaphorical use, critical scholars continue to use caution when employing the phrase 'epidemic.'

Despite positive effects of framing obesity as 'epidemic,' such as increased funding, research on obesity, and public awareness to the seriousness of the condition and prevalence, metaphors of contagion are more harmful than positive. Arguably, when obesity is framed as 'epidemic,' it is culturally understood as being a contaminating condition, which often has an 'Othering' effect. In addition, increasing the pathology and medicalization of obesity works to justify state intervention in public health, putting some vulnerable populations at risk of further exploitation and ill treatment. Furthermore, public health measures continue to target cultural behaviours at the individual and family level, such as diet and exercise habits, despite the 'epidemic' framing suggesting that it is not simply a lifestyle disease.

One way or the other, some scholars have suggested that "in an era when the 'epidemic' metaphor is invoked to describe everything from graffiti to plagiarism, if this figure of speech is not dead yet, it is at least tired" (Mitchell and McTigue 2007, 401). As Moffat suggests, however, "even if we abandon the 'epidemic' metaphor something is bound to replace it: as humans we live by metaphors" (2010, 13). To reiterate Brown's (2014) claim for care when choosing metaphors, medical professionals and academics need to be aware of the complexity of conditions, as well as how

they are experienced, before applying metaphors of contagion.

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REVIEW ARTICLE

Paleopathology, Entheseal Changes, and Cross-Sectional Geometry: The Zooarchaeology of Working Animals

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ABSTRACT

Morphological changes in the skeletons of working animals such as reindeer, horse, and cattle have long been observed and documented in the archaeological record. Activities such as riding, carrying cargo on their backs, and pulling vehicles like sleds and ploughs throughout an animal's life history cause alterations and variations to skeletal tissue. Such alterations include paleopathological lesions, entheseal changes (EC)—alterations in muscle, tendon, and ligament attachment sites on bone—and variations in cross-sectional bone geometry (CSBG). These clues are helpful for reconstructing human-animal relationships in faunal remains of our archaeological past. However, other factors influence the morphological appearance of skeletal tissue besides working activities, such as age, sex, body size, nutrition, genetics, environmental factors, and management by human caretakers. This article explores how paleopathological lesions, EC, and CSBG in faunal skeletal remains are examined to reconstruct working activity and changes to human-animal relationships in the archaeological record. In particular, we discuss two primary topics of inquiry: (1) a review of paleopathological identifiers in working animals such as cattle, horse, camel, and reindeer; and (2) how EC and CSBG are understood in terms of bone functional adaptation, and their application in working and non-working animals such as reindeer and horse. Next, we analyze each topic highlighting their benefits and limitations, including how they contribute to archeological understandings of human-animal relationships in the past, as well as their implications for future research.

Keywords: entheseal changes, bone functional adaptation, paleopathology, human-animal relationships, draught animals, domestication

INTRODUCTION

Changes to animal skeletons are one of the most valuable zooarchaeological approaches to recognize the presence of domestic animals used for their labour in the past. The advent of animal labour had a significant impact on human societies allowing people to travel, produce more food, and transport larger/heavier loads more effectively (Sherratt 1983; Anthony and Brown 2011). Previous research on animal labour has focused on husbandry practices (Losey et al. 2018; Zeder 2006; Russell 2012), as well as the presence of equipment such as ploughs (Bartosiewicz, Van Neer, and Lentacker 1997; Greenfield 2010; Marković and Bulatović 2013; Sherratt 1983), wheeled vehicles (Anthony 2007; Burmeister 2017), sleds (Losey et al. 2018; Pitul'ko and Kasparov 1996; 2017), and harnessing (Anthony and Brown 2011; Fribus et al. 2019; Legrand 2006; Losey et al. 2021). Although extensive, these studies fall short in that they do not directly examine the physiological demand of animal labour largely because material culture related to traction, riding, and carrying is generally rare or absent in the

archaeological record (Thomas et al. 2021, 85). Osteological evidence, however, fills this gap providing a valuable way to infer the presence of and to reconstruct such activity directly observed on animal remains. Not only does examining skeletal morphology help scholars better understand the overall process of animal domestication through human history, but it can also reframe how archaeologists examine the impact of daily human-animal relations, physical activities, and their contribution to large-scale changes over time.

Skeletal changes occurring from biomechanical loading include the development of paleopathological lesions, entheseal changes (EC), and differences in cross-sectional bone geometry (CSBG). Except for acute, traumatic events during work, these changes are a result of long-term habitual activity resulting from the nature of specific relationships between people and animals. These include activities such as pulling, carrying cargo on their backs, and being ridden. Additionally, as we elaborate further in this paper, there are a multitude of biological, environmental, and behavioural factors that also contribute to skeletal change that must be fully considered in any study.

This paper reviews the contributions of paleopathological lesions, EC, and CSBG to zooarchaeological research on working animals, while highlighting the limitations inherent in using these lines of evidence. First, we demonstrate the ways that numerous types of paleopathological lesions have been tied to certain forms of activity and exertion, which must be considered specific to certain species. To do so, we highlight three species of domestic animals that are the most well studied: cattle (*Bos taurus*) and horses (*Equus caballus*) and reindeer (*Rangifer tarandus*). Second, we analyze EC, which allows researchers to reconstruct animal movement and mechanical stress through observations of animal entheses, that is where tendons, ligaments, and muscles connect to bone. Comparison between animals known to have been worked versus those that did not work indicates the effects of labour on the skeleton. Such initiatives have been well demonstrated in humans, (e.g., Hawkey and Merbs 1995; Henderson et al. 2017) but only recently employed in reindeer and horse populations (Niinimäki and Salmi 2016; Bindé et al. 2019). Finally, we investigate CSBG to understand changes in the cross section of long bone diaphyses caused by mechanical loading and make use of similar comparison between worked and non-worked individuals to infer activity. Taken together, each of these methods provide valuable insights into the relationships and mutual activities enacted by people and domestic animals.

PALEOPATHOLOGY OF WORKING ANIMALS

Investigating the ways that animals have been used for activities such as draught work, riding, and carrying cargo demonstrate how people have made use of animal labour in the past. One such avenue is through examining pathological lesions on animal remains from archaeological sites. Both transportation and subsistence practices changed drastically with the introduction of animal labour (Bendrey 2014, 260). Long-term and habitual work, for instance, can manifest as lesions on various parts of the skeleton, such as the distal limbs, vertebrae, scapulae, hip joints, skulls, and teeth. The following section reviews paleopathological lesions that have been used to identify working animals from archaeological sites.

Determining whether an animal was consistently and habitually used for traction, riding, or cargo, and the intensity of that use is not straightforward since many of the activity-related lesions discussed below have multifactorial etiologies that complicate confidence in causality. Animals are not biomechanically adapted for such work; they evolved carrying out natural locomotion and behaviour without the physical stress of pulling or carrying excess weight that humans have employed them to do (Levine, Whitwell,

and Jeffcott 2005, 94; Bartosiewicz 2008, 154; Thomas et al. 2018; Salmi, Niinimäki, and Poulakka 2020, 50). Even domesticated species have not adequately changed enough through artificial selection to be optimized for human-managed work. Further, many lesions associated with working animals also have other factors such as age, sexual dimorphism, environment, and genetic predisposition that influence their expression and can be misinterpreted as signs of labour exploitation (Upex and Dobney 2012). The frequency and severity of lesions present on non-working animal populations acts as a control sample to compare with animals known to have been worked. The patterns of lesions on non-working animals illustrates what can be expected from normal activity during life. The different lesion frequency and severity shown in known-working animal skeletons, therefore, reflects potential indicators of labour exploitation and those indicators can be looked for on archaeological faunal remains (Flensborg and Kaufmann 2012; Taylor, Bayarsaikhan, and Tuvshinjargal 2015; Thomas et al. 2018).

Some species have been more thoroughly studied for draught, riding, and cargo related lesions than others. Many domesticated species are either not well studied, or lesions have not proven to be effective indicators of working activity. While horses, cattle, and reindeer have received significant attention in paleopathological research, other domestic species such as llamas (*Lama glama*) and dogs (*Canis familiaris*) have been explored to a lesser extent (Defrance 2010; Izeta and Cortés 2006; Latham and Losey 2019; Labarca and Gallardo 2015). Patterns of lesions on the skeleton used to identify one species of draught animal may not work for others and those patterns may be specific to a species, equipment, and the nature of the work done.

Horse skeletons are known to show several pathological lesions related to riding and draught use. Much of the literature has focused on lesions on the cranium, mandible, teeth, and spine (Bendrey 2007; Onar et al. 2012; Taylor, Bayarsaikhan, and Tuvshinjargal 2015; Levine, Whitwell, and Jeffcott 2005). Crania and mandibles may show pathological indicators of working activity associated with the use of bits and with strenuous activity such as running or pulling loads. A bit sits within the diastema of the horse's mouth in the space between the incisors or canines and the premolars. Its presence and movement cause irritation in locations dependant on the type of bit used. A strait-shaped bit sitting on the mandibular diastema has been shown to stimulate new bone formation and bone loss on the dorsal surface of the mandibular diastema in horses from Iron Age Britain (800 BC – CE 100) (Bendrey 2007). Robin Bendrey developed a grading system for quantifying these lesions on the diastema in which "palpable small plaques of new bone formation (discontinuous changes) or continuous slight changes" (value of 2) or any degree of bone loss differentiate between a horse that was bitted and one that was not (2007, 1043–44). These changes may reflect how much rein pressure was used. Similarly, a curb bit has been suggested to cause lesions on the bony palate, sometimes severe enough to cause perforations of the bone as seen in Byzantine horses recovered in Istanbul (Onar et al. 2012).

Bit use also wears and damages the dentition, particularly the mandibular second premolar. A rectangular area of wear of the mesial edge of this tooth (greater than 5mm in height) has been used as an indicator of bit wear as opposed to normal wear from chewing food (Bendrey 2007). A bevel on the mesial-occlusal corner (forward facing margin of tooth towards the plane where the maxillary and mandibular cheek-teeth contact) of this molar may also indicate bit chewing behaviour or intentional rasping (to prevent serious chipping and cracking) but can also result from malocclusion. More pronounced tooth wear could occur if the horse habitually held the bit

firmly between its upper and lower teeth causing a worn depression on the occlusal surface of the second premolars (Bartosiewicz and Gál 2013, 134).

Cranial morphological changes have been linked with riding behaviour and exersion as seen in horses in Mongolia (Taylor, Bayarsaikhan, and Tuvshinjargal 2015) and China (Li et al. 2020). Medial and lateral grooves present on the dorsal border of the premaxilla are thought to develop through activity from the muscles and cartilage when flaring their nostrils (Taylor, Bayarsaikhan, and Tuvshinjargal 2015, 859). Similarly, a more pronounced nuchal ligament attachment may develop with increased neck and head movement associated with riding; however, the etiology is complex, with advancing age and increased behavioral stress causing similar developments (Taylor, Bayarsaikhan, and Tuvshinjargal 2015, 857–58).

Horse vertebrae are especially susceptible to lesions caused by pressure from the weight of the rider which can cause osteophytes to develop on the thoracic vertebrae on the lateral and ventral margins of the vertebral body as well as on and adjacent to the articular processes (periarticular osteophytes) (Levine, Whitwell, and Jeffcott 2005). Since the spinous processes carry much of the rider's weight, they develop impinging or overriding distal ends that start to touch and overlap with neighboring spinous processes (Levine, Whitwell, and Jeffcott 2005, 104). The above lesions are also associated with congenital conditions or the natural ageing process; however, riding activity does seem to accelerate these processes (Levine, Whitwell, and Jeffcott 2005). In contrast, horizontal fissures (oriented mediolaterally) on the epiphyses of the vertebral body do not seem to develop naturally in non-working horses (Levine, Whitwell, and Jeffcott 2005, 98). Horizontal fissures are speculated to occur from poorly fitting saddles and jumping the horse while riding (Levine, Whitwell, and Jeffcott 2005, 98).

More extreme occurrences of osteophytes can develop into ankylosis, or fusion, of two or more vertebrae with some severe conditions observed in archaeological equid remains (Onar et al. 2012; Janeczek et al. 2014; Fribus et al. 2019). Nemanja Marković and colleagues (2019) caution against confusing these lesions for Diffuse Idiopathic Skeletal Hyperostosis (DISH), a disease that similarly causes vertebral fusion but does not seem to have an etiology associated with draught use. The way horses were used has a major effect on how pathological conditions may manifest on the vertebrae. As expected, horses used to pull chariots or similar vehicles show lower frequencies of lesions and very few occurrences of horizontal fissures on the epiphyses and impinging spinous processes (Li et al. 2020, 29572). Riding horses can be differentiated from those used to pull chariots through this difference in lesion frequency.

Cattle have an extensive history of draught use by humans. As such, a significant amount of research has focused on identifying osteological evidence of working cattle (Bartosiewicz 2008; Bartosiewicz Van Neer, and Lentacker 1993; 1997; De Cupere et al. 2000; Groot 2005; Holmes, Thomas, and Hamerow 2021; Milisauskas & Kruk 1991; Rassadnikov 2019; Telldahl 2012; Thomas 2008; Thomas et al. 2018, 2021; Thomas & Johannsen, 2011). Indications of draught work include skeletal lesions on the distal limbs, hip joint, horn cores, and first thoracic vertebra. Alternative or complicating factors in developing pathological conditions need to be considered including age, body weight, genetic predisposition, nutrition, environment, shelter, long distance travel, and veterinary care (Telldahl 2012; Holmes, Thomas, and Hamerow 2021; Rassadnikov 2021).

Ring-shaped depressions near the base of horn cores have been interpreted as evidence of yokes being fixed to, exerting pressure, and

stimulating adaptive remodelling on the horns (Milisauskas and Kruk 1991; Bartosiewicz, Van Neer, and Lentacker 1997, 12, 72; Bartosiewicz and Gál 2013, 131–32; Thomas et al. 2018). However, similar depressions have been known to develop on the horn cores of non-working cattle. Richard Thomas and colleagues (2018) provide an example of a feral bull at least ten years old at death showing a similar ring-shaped depression. This animal was never worked. The etiology of this lesion may be like "thumbprint" depressions representing localized resorption of bone minerals found on several domesticated and wild bovids (Thomas et al. 2018, 142). A similar impression on the first thoracic vertebra has been suggested to be caused by pressure from yokes that rest over the neck and shoulder (Bartosiewicz, Van Neer, and Lentacker 1997, 12; De Cupere et al. 2000, 255). Unlike horses, vertebral pathological defects are not prevalent in working cattle (Bartosiewicz 2008, 156–57), though twisting deformation of the spine may indicate that animals were part of a team, consistently on either the right or left side of a plough (Upex and Dobney 2012, 199–200).

Cattle naturally have high tendencies towards pathological defects in the distal limbs, especially in the forelimb where approximately two-thirds of their body weight rests (Bartosiewicz, Van Neer, and Lentacker 1993; Bartosiewicz 2008, 160–61). As a result, the metacarpals tend to develop asymmetry more easily (Bartosiewicz, Van Neer, and Lentacker 1993; Groot 2005; Rassadnikov 2019). The skeletal element becomes wider and more robust with a greater mineral density and thicker cortical bone on the medial portion of the diaphysis. This condition develops with advanced age and is intensified by larger body weight and increased physical activity (Bartosiewicz, Van Neer, and Lentacker 1993). Other elements of the distal limbs in cattle are also prone towards pathological defects and lesions, especially the phalanges and metapodials. (Bartosiewicz, Van Neer, and Lentacker 1993; Bartosiewicz 2008, 160–61). These lesions include exostosis, ankylosis, periarticular lipping, and eburnation, and have been observed in draught oxen, feral cattle, and aurochs (Thomas et al. 2021, 88). In cattle that have been used for draught work however, more biomechanical power is needed to propel forward coming from the hindlimbs (Bartosiewicz, Van Neer, and Lentacker 1997, 157; Holmes, Thomas, and Hamerow 2021, 265), especially when gaining initial momentum when pulling a heavy load (Bartosiewicz and Gál 2013, 152). As such, an increased frequency of lesions in hindlimb elements are suggestive of draft cattle (Bartosiewicz 2008, 156, 162; Bartosiewicz and Gál 2013, 152). The Pathological Index method developed by László Bartosiewicz, Wim Van Neer, and An Lentacker (1997) demonstrate this pattern which quantifies the presence and severity of lesions on phalanges and metapodials on an individual, facilitating comparison both within and between populations (see also Holmes, Thomas, and Hamerow 2021). When applied to entire assemblages of faunal remains from archaeological sites, this method reveals larger trends of lesion frequency, severity, and skeletal distribution. However, herd management practices of non-working cattle should be considered. The availability of shelter, travel for pasturing, veterinary care, and diets that encourage fast weight gain also promote development of pathological lesions that overlap with what is seen in draught cattle (Rassadnikov 2021).

The increased severity of work done by the hindlimb is also explored in hip joint disease, developing lesions on the femoral head and acetabulum (Groot 2005; Bartosiewicz, Van Neer, and Lentacker 1997, 12). However, Richard Thomas and colleagues (2021, 85) outline problems with relating hip joint disease to draught work: factors other than draught use contribute to hip joint disease (for example age, sex, body weight, and management practices),

such lesions occur infrequently, the elements are often fractured antemortem or postmortem which hinders identification, and only extreme cases are often reported.

Reindeer also work in a variety of activities including pulling sleds, carrying cargo on their backs, riding, and racing (Salmi, Niinimäki, and Pudas 2020; Nomokonova et al. 2020). Vertebral pathological lesions have been found in higher frequencies in working reindeer. In a study involving twenty-six working (pulling, carrying, and racing) reindeer and one hundred and eight non-working reindeer skeletons from Scandinavia and Siberia, the working reindeer scored higher pathological indices for joint disease on the cervical, thoracic, and lumber vertebrae (Salmi, Niinimäki, and Pudas 2020). In these cases, degenerative joint disease was indicated by osteophyte growth on vertebral bodies, articular surface erosion, new bone growth on vertebral processes, and ankylosis between vertebral bodies; warped spinous processes were also observed in this study. Lower cervical and thoracic vertebra showed degenerative joint disease in two Finnish racing reindeer (non-ridden individuals), suggesting that force from the harnesses contributed to the onset of disease on the animals' spines. Reindeer from Siberia that were worked and have known histories had some deformed spinous processes on their vertebrae, possibly caused by asymmetrical harnessing, and osteophytes had developed on the margins of the vertebral bodies (Salmi, Niinimäki, and Poulakka 2020, 51). Riding may have caused these lesions. An individual reindeer ridden by a heavy person is similar example; this animal had ankylosis of four thoracic (T9–12) vertebrae (Salmi, Niinimäki, and Pudas 2020, 63).

Pathological lesions on the distal limb bones, including phalanges, metapodials, and calcanei have been identified as indicators of working reindeer. The Pathological Index has been applied to the analysis of lesions on reindeer phalanges and metapodials and was expanded to record vertebral, coxal, and long bone lesions as well (Salmi, Niinimäki, and Pudas 2020, 60). For individuals from Northern Scandinavia and Siberia that were known to have pulled sleds, the authors found that the forelimb phalanges showed greater pathological changes such as exostoses and lipping compared with the hindlimb (Salmi, Niinimäki, and Pudas 2020; Salmi et al. 2021, 6; Nomokonova et al. 2020).

Additionally, an irregular new bone growth on the caudal side of a reindeer calcaneus from Iarte VI, located in the Iamal Peninsula of Arctic Siberia, may have been caused by a work-related injury (Nomokonova et al. 2020). Although the cause in this case is not certain, the calcaneus can be injured by a sled running accidentally into the back of the leg. Anna-Kaisa Salmi, Sirpa Niinimäki, and Tuula Pudas (2020, 61) also saw a high occurrence of calcaneus and talus lesions, but only a relatively small sample (4 individuals) of those elements were available.

Other domesticated animals used for draught work in Siberia have either not received as much attention or have been found not to have strong pathological indicators of work. For dogs for instance, no such connections between labour and pathological lesions have been found that adequately differentiate working and non-working individuals. Katherine Latham and Robert Losey (2019) investigated whether a greater frequency of spondylosis deformans is experienced by sled dogs; however, this disease was found to be multifactorial and happened at similar frequencies in sled dogs and wolves, with a slightly greater occurrence in non-transportation dogs.

Although no studies identify working camels using osteological lesions, llamas used for carrying cargo in the Andes have been found to have increased frequencies of lesions on phalanges (forelimb and hindlimb) and vertebrae compared to non-working camelids

(Izeta and Cortés 2006; Defrance 2010; Labarca and Gallardo 2015).

As demonstrated, paleopathology of draught animals provides promising value for identifying working animals and investigating the nature and intensity of animal labour exploitation. In all cases, it is crucial to remember that many of the lesions associated with work have complex etiologies related to age, sex, nutrition, trauma, genetic susceptibility, and other factors (Thomas et al. 2018). This is often addressed using comparison between lesions frequencies on working and non-working animals, as labour exploitation can exaggerate conditions occurring with age (Levine, Whitwell, and Jeffcott 2005). Although the number of domesticated species investigated in the literature is limited, existing methods and general trends can be adapted to other species to provide insight into the occurrence and intensity of draught, riding, and cargo animals from archaeological contexts.

RESEARCH ON ENTHESEAL CHANGES IN WORKING ANIMALS

Researchers seek to reconstruct physical activity in zooarchaeological remains to identify changes in human-animal relations throughout history. As demonstrated above, examining paleopathological markers on faunal remains has been helpful to locate domestication-related activities in the archaeological record (e.g., Bartosiewicz, Neer, and Lentacker 1997; De Cupere et al. 2000; Telldahl 2012). However, identification of more specific physical activities would require further study of muscle use and its various effects on skeletal remains. Instead, researchers use variations to entheses–attachment sites for muscles, tendons, and ligaments on bone–called entheseal changes (EC) to identify more specific physical activity patterns in human and faunal remains (Jurmain et al. 2012; Salmi and Niinimäki 2016). EC have a multifactorial etiology, meaning that there are other factors such as age, sex, body size, and population genetics that influence entheseal morphology and complicate our interpretations (Benjamin et al. 2002; Henderson et al. 2017; Jurmain et al. 2012).

Examining the effect of physical activity on EC and other non-pathological skeletal morphologies requires researchers to utilize methodologies under the concept of bone functional adaptation, formerly known as Wolff's Law (Ruff, Holt, and Trinkaus 2006; Wolff 1986). This concept is understood as "form follows function," meaning that trabecular and cortical skeletal tissue remodels over time to disperse mechanical loading forces (Benjamin et al. 2006; Ruff, Holt, and Trinkaus 2006). Essentially, mechanical overloading causes microdamage to musculoskeletal tissue and stimulates bone cells into osteoblastic (bone-forming) and osteolytic (bone-reducing) activity, continuing this process through stages of growth, destruction, and maintenance over time (Benjamin et al. 2006; Ruff, Holt, and Trinkaus 2006).

In this case, entheses act to dissipate mechanical stress across the hard-soft tissue boundary when muscles contract to create movement, which distributes force more efficiently (Benjamin et al. 2002; 2006). The transfer of strain is essential for minimizing the risk of damage such as tearing and avulsion fractures in which the soft tissue is pulled away from the bone (Benjamin et al. 2002; Ruff, Holt, and Trinkaus 2006). The structures surrounding the enthesis, such as bursae and fat pads, are also part of an "organ complex," as they assist in dissipating mechanical stress and thus are also affected by the same factors that influence entheseal morphology (Benjamin and McGonagle 2009). Entheses are split into two histological types, fibrous (FE) and fibrocartilaginous (FCE), varying in shape and size depending on their attachment sites (Benjamin et al. 2002; 2006). It is essential to acknowledge the two types of entheses because their histology and attachment angle

affect their morphological appearance differently, therefore impacting their interpretation through EC analysis (Villotte et al. 2010; Henderson et al. 2017).

EC, formerly known as musculoskeletal stress markers (Hawkey and Merbs 1995), are non-pathological reflections of bone formation and destruction that can vary from osteophytic activity producing roughness, bony crests, ridges, and enthesophytes or osteolytic formations like erosions, cavitations and macro- and microporosity (Foster, Buckley, and Tayles 2014; Hawkey and Merbs 1995; Henderson et al. 2017). EC methods work under the concept of bone functional adaptation, which defines how skeletal architecture remodels over time to disperse mechanical loading more efficiently (Wolff 1986; Ruff, Holt, and Trinkaus 2006). In other words, microdamage at the hard-soft tissue boundary on entheses encourages blood flow and bone cell activity that alters its shape, size, and appearance (Jurmain et al. 2012). Under this assumption, EC that have more morphological changes are attributed to higher physical activity levels. However, this does not imply that individuals showing little to no EC did not participate in activities, as the etiology of EC is multifactorial (for a more detailed summary of human EC research, see Sick 2021).

The first methods developed to study EC in the 1980s and 1990s were observational. In 1995, Dianne Hawkey and Charles Merbs created the first method intended for widespread use, visually scoring three EC features using a three-point ordinal scale. This protocol and others in the early 2000s (e.g., Mariotti, Facchini, and Belcastro 2004; 2007) have since been criticized for failing to integrate clinical literature, having poor intra and interobserver error, and their simplistic interpretations regarding physical activity given new knowledge on the multifactorial etiology of EC (Jurmain et al. 2012; Villotte et al. 2010). The most up-to-date scoring protocol, called the Coimbra method (Henderson et al. 2013; 2017), was adapted from previous works (Mariotti, Facchini, and Giovanna Belcastro 2004; 2007; Villotte et al. 2010) and intended for fibrocartilaginous entheses only, split into two Zones. Zone 1 is the thin margin of the enthesis reflecting the most oblique angle of soft tissue, and Zone 2 is essentially the rest of the entheseal surface (Henderson et al. 2013; 2017). Additionally, this method considers the impact of age, sex, and body size on EC by using multivariate statistics, allowing for higher observer reliability (Henderson et al. 2013; 2017).

Observational methods have some drawbacks, namely the influence of human subjectivity on observer bias and the low statistical power of ranked scoring systems, which reduces observer error and negatively impacts the detection of statistical patterns (Nolte and Wilczak 2013). A recent workaround is to apply quantification protocols that use 2D and 3D technology to examine the shape and size of entheses to identify EC patterns, due to having high precision and low observer error (Sick 2021). However, these methods are expensive (e.g., Nolte and Wilczak 2013; Nikita et al. 2019). Quantification studies have proven helpful in examining the direct link between EC and activity in experimental animal models (e.g., Zumwalt 2006; Rabey et al. 2015; Wallace et al. 2017; Turcotte et al. 2022), and more recent applications in archaeological remains (e.g., Karakostis et al. 2021). However, the first visual methods explicitly created for non-human animals weren't considered until recently (e.g., Bindé, Cochard, and Knüsel 2019; Salmi and Niinimäki 2016; Niinimäki and Salmi 2016; Salmi, Niinimäki, and Pudas 2020; Niinimäki and Salmi 2021. See Table 1 for summary).

Niinimäki and Salmi (2016) and, later, Salmi and Niinimäki (2016) explore the effect of a visual EC method modified from Villotte (2010) and the Coimbra method (Henderson et al. 2013; 2016). The first study examined pathological lesions and EC on four male

reindeer with known life histories of racing, riding, and pulling sleds (Niinimäki and Salmi 2016). Though the sample size was too small to draw links between activity in this case, the authors' later publication expanded their study to twenty five male and female zoo reindeer and twenty-eight free-ranging males and females using the same modified scoring protocol (Salmi and Niinimäki 2016). They found that the elbow flexors in larger male free-ranging reindeer showed higher EC scores than the zoo reindeer, which they attributed to differences in feeding behaviour (Salmi and Niinimäki 2016). For example, free-ranging animals repeatedly dug through the snow to eat lichen throughout the winter, whereas humans fed zoo reindeer through the cold months, effectively negating this behavior (Niinimäki and Salmi 2016). The authors also found zoo reindeer with more EC in the subscapularis, where such an attachment is associated with engaging their shoulder bracing apparatus for standing still over long periods (Hull, Niinimäki, and Salmi 2020).

Salmi, Niinimäki, and Tuula Pudas (2020) applied the same scoring method to twenty six working reindeer used for pulling, riding, and racing and fifty non-working reindeer in a more extensive study. Working reindeer found higher scores for the triceps brachii attachment (proximal humerus), which works to pull body weight over the shoulder joint, affecting this muscle when bearing additional weight (Salmi, Niinimäki, and Pudas 2020). In the hindlimb, EC scores of the proximal femur (especially the vastus lateralis and quadriceps femoris, responsible for hip and knee flexion) were significantly higher in working reindeer, attributed to the range of motion required for greater speed in racing. Overall, they found higher EC scores in working reindeer on muscle attachments used to extend and flex the shoulder, hip, and knee joints, possibly inferring to various activities involving pulling, carrying, and racing (Salmi, Niinimäki, and Pudas 2020).

Though reindeer are the primary species examined in non-human EC research, Marion Bindé, David Cochard, and Christopher Knüsel (2019) expanded these studies to equids by analyzing the remains of thirty nine captive but non-working horses, donkeys, and zebras using protocols modified from Villotte (2010), the Coimbra method (Henderson et al. 2013; 2017), and the method by Salmi and Niinimäki (2016; Bindé, Cochard, and Knüsel 2019). These animals were unworked, as this study aimed to establish a baseline for entheseal variation and the influence of age and sex on EC in the appendicular skeleton by ranking EC into categories of A, B, and C (Bindé, Cochard, and Knüsel 2019). Like reindeer, the results showed both age and sex to be significant confounding biological variables. Older individuals (16 or older) typically increase in B and C scores in some entheses, with one exception being a ligament on the second phalanx (Bindé, Cochard, and Knüsel 2019). In contrast, other muscle insertion sites on bone showed no changes among all age sites. These include the biceps brachii, flexor digitorum superficialis, triceps brachii, and the medial collateral ligament of the posterior proximal phalanx (Bindé, Cochard, and Knüsel, 2019). As for sex differences, males showed higher EC frequencies except for flexor digitorum superficialis on the femur and the medial collateral ligament on the posterior proximal phalanx (Bindé, Cochard, and Knüsel, 2019). Interestingly, neither age or sex affected two entheses on the humerus and showed only slight variation, indicating that these attachments may be a valuable indicator of activity in zooarchaeological remains (Bindé, Cochard, and Knüsel, 2019).

In terms of confounding factors affecting EC morphology, age, sex, and body size were found to have significant effects in non-human studies on reindeer and equids, albeit in different ways considering anatomical differences between species. Age was a significant

contributor to EC morphology in all these studies, though this variable had to be metrically estimated in three of them (Bindé, Cochard, and Knüsel 2019; Niinimäki and Salmi 2021; Salmi, Niinimäki, and Pudas 2020). Human EC studies note that entheseal degeneration in older individuals tend to be greater, which may be caused by overall reduction in physical activity and osteoblast reduction due to the natural aging process (Henderson et al., 2017). In addition, the accumulation of muscle use, mechanical overloading, and acute events of physical trauma through the years may also explain these findings (Villotte et al., 2010). Since age seems to have a similar impact on equids and reindeer, Bindé, Cochard, and Knüsel (2019) caution the inclusion of older estimated individuals where age is unknown since this can bias EC analysis. Additionally, body size was a significant contributor, where all studies had EC score distributions favouring larger males (Bindé, Cochard, and Knüsel 2019; Niinimäki and Salmi 2016; Salmi and Niinimäki 2016; Salmi et al. 2021). Although multivariate analysis is helpful in separating the influence of these factors on entheseal morphology, there are other limitations when considering their impact on reindeer and equids. For instance, the intertwined nature of sexual dimorphism and body size in non-human studies is still debatable in terms of entheseal morphology (Bindé, Cochard, and Knüsel, 2019; Niinimäki, 2012). Niinimäki and Salmi (2021) note that measurements to estimate sex in reindeer are biased with weight estimation because of sexual dimorphism, suggesting that assessment of sex reflects body size rather than hormonal differences. Additionally, males in two reindeer studies (Niinimäki and Salmi 2021; 2016) were castrated, whereas others were not. Despite the observation that all larger-bodied individuals were exclusively male, hormonal differences in this sample may have unknown effects on EC variation (Niinimäki 2012).

Some other potential influences when adapting EC methods to non-humans could include differences in average lifespans between species or effects of bipedal versus quadrupedal locomotion on EC (Ruff, Holt, and Trinkaus 2006). Moreover, anatomical differences from humans seem to reflect EC

Article	**Species**	**Sex**	**Age**	**Life Histories/known activities**	**Total # of ind. used**
Salmi and Niinimäki (2016)	*Rangifer tarandus*	Male	5.5 to 11-13 years	Pulling sleds, carrying loads, riding	**4**
Niinimäki and Salmi (2016)	*R. tarandus, R. fennicus*, and hybrids (*R. tarandus x R. fennicus*)	Male (18), Female (36)	2-10 years, average age 3.5-4.5 years	2 working (pulling, carrying and racing) and 51 nonworking	**53**
Salmi, Niinimäki, and Pudas (2020)	*R. tarandus, R. fennicus*, hybrids	Male	3-10 years	26 Working (pulling, carrying, and racing) and 50 nonworking	**81**
Niinimäki and Salmi (2021)	*R. tarandus, R. fennicus*, hybrids	Male, Female	2-10 years, average age 3.5-4.5 years	Nonworking	**53**
Bindé et al. 2019	*Equus caballus*, Prezwalski's horses (*E. caballus prezwalski*) donkey (*E. Asinus*), mule (*E. asinus x E. caballus*), zebra (*E. greyvi, E. burchelli*)	Male (20), Female (19)	50 days to >20 years	Nonworking	**39**

Table 1–*Summary of EC research in non-human animals (Source: Created by Jessica Sick 2022)*

variation differently, supported by observations of some fibrocartilaginous entheses on horses and reindeer reflecting greater normal variability than expected in humans (Benjamin, Evans, and Copp 1986; Bindé, Cochard, and Knüsel 2019). For instance, the amount of expected EC reflecting bone resorption was observed less in non-humans compared to human studies, again indicating that EC differ between species (Bindé, Cochard, and Knüsel 2019; Niinimäki and Salmi 2021)

Despite these contradictory factors, the application of EC methods to reindeer and equids reveals some benefits in terms of reconstructing patterns of activity compared to humans. For one, EC research tends to reflect the overall intensity and duration of mechanical loading on entheses, which is then attributed to more specific physical activities (Lieverse et al. 2013). These activities are easier to analyze in working animals because said work is better described, more specific, and typically lifelong (Salmi et al. 2021). For example, reindeer used for pulling sleds usually begin working before adulthood and typically perform such work throughout life, whereas human occupations are more difficult to track due to their high variability in EC literature (Alves Cardoso and Henderson 2013; Salmi et al. 2021). Overall, EC studies in non-humans have shown merit in reconstructing past activity in working animals. Future research will allow studies to compare wild and domesticated animals of the same species to pinpoint milestones in human change, such as human migration and cultural transitions from hunting and gathering to agriculture or pastoralism (Salmi et al., 2021). In addition, these studies may also reveal transitions in human-animal interactions regarding how they train, work, and breed livestock, indicating broader social or economic changes

CROSS-SECTIONAL BONE GEOMETRY AND BONE BIOMECHANICS IN WORKING ANIMALS

Although EC can indicate more specific activities, CSBG analysis in long bones has an extensive history and better understood methodology and association with activity. (Jurmain et al. 2012; Ruff, Holt, and Trinkaus 2006). In animals, a cross-sectional study has also shown direct associations between bone plasticity and its response to human-controlled activities in donkeys (Shackelford, Marshall, and Peters 2013). In addition, new research on types of human-raised and wild reindeer populations in the North has extended the use of CSBG methods to not only evaluate the efficacy of EC scoring methods (Niinimäki and Salmi 2021) but to demonstrate its potential as a valuable indicator of changes in human-animal relations over time (Pelletier Niinimäki, and Salmi 2021).

Pelletier, Niinimäki, and Salmi (2021) argue that quantification analysis such as 2D-geometric and morphometrics can compare CSBG properties between species to identify differing impacts of locomotion on bone structure, including parameters such as body size, sex, and habitual activity. Their study examined the cross-sections of eighty nine free-range, twenty eight non-working, and twenty working male and female reindeer, noticing some interesting trends. They found non-working reindeer and free-ranging reindeer (captive during the winter) had increased body mass, decreased body size, and thicker cortical cross-sections than wild reindeer. The authors attributed this to differences in feeding and locomotion behaviour, such as wild reindeer foraging through the snow for lichen or captive reindeer requiring more body support for standing still for long periods (Pelletier, Niinimäki, and Salmi 2021; Niinimäki and Salmi 2016; Hull, Niinimäki, and Salmi 2020). This behaviour typically begins in adolescence, when bone growth is the most susceptible to activity (Jurmain et al., 2012; Niinimäki and

Salmi, 2021). The authors argue that future studies using CSBG in juveniles could prove a helpful tool for reconstructing activity (Pelletier, Niinimäki, and Salmi 2021).

Given the intertwined nature with CSBG and EC in bone functional adaptation and our better understanding of CSBG properties, authors have used CSBG in human EC studies to understand better their covariation with activity, as well as to test the efficacy of EC methods (Niinimäki 2012; Michopoulou, Nikita, and Henderson 2017; Michopoulou, Nikita, and Valakos 2015). Niinimäki and Salmi (2021) explored the covariation in reindeer by analyzing the cross-sections and EC of 50 wild forest, domesticated free-range, and zoo reindeer. They found that bone formation on almost every examined enthesis was positively associated with CSBG values, further establishing their relationship from previous studies on humans (Niinimäki and Salmi 2021; Pelletier, Niinimäki, and Salmi 2021). Additionally, they found that entheses on the humerus effectively separated different groups of reindeer based on activity levels that size nor age could entirely account for, implying activity as a possible underlying factor causing these observations (Niinimäki and Salmi 2021; Salmi, Niinimäki, and Pudas 2020). They also noticed translation on entheseal variability from humans to reindeer might also cause false rejections or acceptances of an enthesis in its link to activity based on visual observation, reflecting the same concerns as Bindé, Cochard, and Knüsel (2019) (Niinimäki and Salmi 2021). To counter this, they suggest using methods specific to each enthesis and always considering potential cross-species differences. The authors also stress that these results are tentative due to their indirect interpretive nature, considering the multifactorial etiology of EC and its association with CSBG values. However, they are optimistic in using these methods and encourage future research of this type to consider CSBG as a supporting or alternative method to reconstruct activity among non-humans.

CONCLUSION

There are multiple different pathways to explore observable morphological changes in faunal skeletal remains to reconstruct human-animal relations. Paleopathological markers such as vertebral fusion or exostoses in the limbs and hip joints can indicate pulling and riding activities in reindeer, horse, and cattle. Some markers are more specific to the working lives of certain species, such as cranial shape and tooth wear in horses from bridles and bits, or indentations in the horn cores of cattle. Non-pathological indicators based upon bone functional adaptation such as EC and CSBG have been well-demonstrated in human skeletal remains, but only recently applied to horse and reindeer. Observational studies applying a new EC method in free ranging and zoo reindeer showed different EC patterns in the forelimb and shoulder, attributed to differences in wild feeding behaviour and low mobility in captivity. Additionally, the new observational scoring protocol by Bindé, Cochard, and Knüsel in 2019 using EC on unworked equids serves as a useful baseline for future studies identifying working activity in equid skeletal remains.

However, researchers must also consider other influences of faunal skeletal morphology besides activity, as their etiology is multifactorial. EC expression in both working and non-working reindeer and equids tend to be highest in older, larger males due to the confounding effects of age, sex and body size on EC morphology. Additionally, these factors seem to affect skeletal morphology differently between species. Pathological lesions are naturally more prevalent in draught cattle and appear more frequent in working horse and reindeer, whereas a study examining the same connection in dogs failed to find similar patterns (Latham and Losey 2019; Levine, Whitwell, and Jeffcott 2005; Salmi, Niinimäki,

and Pudas 2020; Telldahl 2012). This type of research can help to reveal new insights into the integrated nature of daily human-animal interactions and its impact on long-term changes in skeletal morphology. The presence of domesticated animals such as horse and reindeer in archaeological sites do not directly imply that these animals were worked unless accompanied by supplementary material or ethnographic data, only that they lived their lives alongside—or adjacent to—humans. Examination of EC and CSBG values may further reveal information regarding their roles in daily life, such as whether they were exclusively used for certain tasks such as carrying and pulling loads or had a more flexible and varied life histories. By integrating statistical protocols, experimental animal models, and additional biomechanical data such as CSBG, researchers have been able to demonstrate more clear links between physical activity and skeletal morphology in working animals. Future research of this type is encouraged to further benefit studies examining human-animal relationships using faunal skeletal remains..

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REVIEW ARTICLE

Lesbian Motherhood and Artificial Reproductive Technologies in North America: Race, Gender, Kinship, and the Reproduction of Dominant Narratives

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ABSTRACT
This paper reviews current ethnographic literature on lesbian motherhood as it relates to artificial reproductive technologies (ART) through intersectional, biopolitical and critical-race frameworks. I argue that white, lesbian intending mothers' intersecting identity markers of whiteness and queerness place them in a unique position within ART discourses. ART functions as a biopolitical mechanism, which aims to normalize and naturalize privilege in hierarchized power structures, while suggesting that the meanings that it produces are objectively scientific rather than socially constructed. I propose that ART mechanizes white lesbian women's insecurities as queer women, nearing the falsified construction ideal motherhood, by exerting pressure on them to conform and therefore, reproduce dominant reproduction narratives. Simultaneously, I assert that white, lesbian, intending mothers' positionality could enable critical interrogation into the harmful social stratifications that ART perpetuates based on race, class, ability, and sexuality. In sum, a review of relevant literature is used to posit that women privileged within dominant ART discourses must utilize that privilege to create meaningful change.

Keywords: lesbian, queer, motherhood, artificial reproductive technologies, critical-race theory, intersectionality, biopower

INTRODUCTION

Lesbian motherhood commonly signifies a site of resistance capable of subverting traditional, North American, nuclear family formation and gendered kinship roles by isolating parenthood from fatherhood and patriarchy (Lewin, 2016; Herbrand 2018, 311). However, in-depth ethnographic inquiry has revealed that lesbian family formation in North America often works within the boundaries of nuclear family structures (Lewin 2016).

Artificial reproductive technologies (ART) can produce a similar disruptive imagery of a family detached from fatherhood and patriarchy through anonymous donor options (Ryan and Moras 2017, 581; Cutas et al. 2014). When lesbian motherhood is adjoined with ART, access to ideal motherhood, and as an extension, womanhood is granted to some and denied to others (Lewin 1993, 192). Although ART providers have recently attempted to make the technology appear more accessible, it continues to subtly promote white[1], feminine, middle-class, and able-bodied as ideal

[1] Throughout this paper Black will be capitalized while white will remain lowercase. Capitalizing the "B" in Black has become an increasingly common practice that respects a common Black identity while still affirming the social construction of Blackness as a racial category (Chicago Manual 2020). Underlying the argument presented in this

and natural in the context of family formation in North America (Pande 2021, 342; Goodrow 2019; Davis 2020, 58). As a result, racialized, masculinized, low-income, and disabled bodies are often exoticized or left out of popular queer reproductive and ART discourses.

Dominant discourses embedded in structures that dictate the hierarchies of gender, race, ability, class, and sexuality are often reified rather than resisted in white, lesbian family-building, particularly when compounded with ART (Goodrow 2019, 140). This is achieved through the naturalization of socially dominant categories subtle socio-scientific discursive practices produce (Foucault 1984b, 172; 1984a, 259). For example, Goodrow suggests that the most cutting-edge ART, preimplantation embryo selection technologies, enables parents to choose social sex, physical characteristics, and genetic predispositions through advanced science, while subtly encouraging the attenuation of disability, neurodivergence, and difference (2019, 148). I argue that while all individuals, including white lesbian mothers, are constrained by the ideal family narrative, the material effects of these limitations are felt most significantly by individuals with additionally minoritized subject positions. Further, as a biopolitical mechanism, ART reproduces and sustains hegemonic ordering through naturalization, which deters white privileged lesbian mothers from pursuing subversive approaches to familial relationality and imaginative queered kinship.

This article is divided into three main sections, all of which are grounded in ethnographic, intersectional, and critical-race theory frameworks (Crenshaw 1990; Fassin 2011). First, I outline a history of meaning making surrounding North American (NA) motherhood to contextualize the anthropological study of lesbian motherhood in NA, and how motherhood and femininity are constructed and constrained within prescriptive notions of the nuclear family. Second, using Foucault's theory of biopower, I examine ART as a biopolitical mechanism that functions to reproduce subjugating discourses surrounding race, ability, class, and sexuality. Finally, I consider the ways that ART and white, upper-middle-class lesbian family-building intersect and sustain one another by normalizing specific subject positions while further marginalizing others.

LESBIAN MOTEHRHOOD IN NORTH AMERICA

North American Motherhood and the Nuclear Family

Dominant NA power structures are dependent on controlling the sexual behaviours and kinship practices of their citizens (Stoler 1989, 634; Foucault 1984a, 267 Tallbear 2018, 146). Foucault famously argued that in the nineteenth century, "sex became a crucial target of power organized around the management of life…" (1984a, 268). Middle-class white morality was tied to colonial women, who were secured to the private sphere of the home (Stoler 1989, 649). Correspondingly, heterosexual monogamous marriage was intimately connected to the construction of NA nation-states (Tallbear 2018, 146). While colonizing women were pressured to reproduce, Black and Indigenous women's sexualities and reproduction were scrupulously and unjustly governed and constructed in deleterious ways (Davis 2020, 56). From the onset of European colonization

article is the identification of both Black and white as socially constructed racial categories imbued with social meanings that generate material consequences. In recognition that whiteness is a racial category, many scholars and activists have chosen to capitalize the "W" in white. However, capitalizing white also risks emulating rhetoric of white supremacy (Laws 2020). Further, a capitalized white stipulates a common shared identity across white identifying people, which may exist, but is largely cohered through the construction of a hierarchized other that secures the privileged position of whiteness as a racial category. For these reasons, while this paper argues that recognizing whiteness as a racial category is critical for social change, white will remain all lower-case.

in NA during the 1600s, interracial marital and sexual contact were closely monitored and regulated by colonial authorities (Stoler 1984). Stoler argues that from early colonization through to the twentieth century, the construction of racial categories was necessary for colonial control (Stoler 1984, 635). Due to their reproductive capacity, women were categorized as either white or racialized (Stoler 1984, 635). Along with restricting prescribed gender roles, these categorizations became exceedingly important for the symbolic justification of colonial conquest (Stoler 1984, 643). White European women were representatively bound to national purity and the nuclear family, while racialized women were representatively bound to degeneration from this purity; from there, long, documented histories of racialized eugenics in colonial nations emerged (Stoler 1984, 635; Goodrow 2019 ,139–143; Levine 2010, 51–52; Davis 2020, 56).

While racialized men were largely targeted by the justice system for interacting with white women, racialized women encountered eugenic technologies justified by scientific rhetoric and medical procedures, such as forced sterilization (Stoler 1984, 644). Simultaneously, Black and Indigenous populations in NA were subject to medical experimentation, such as the infamous J. Marion Sims experiment, in which enslaved Black women were exploited to develop procedures to repair vesicovaginal fluids (Davis 2020, 61). In these experiments the women were not offered anesthesia. Davis notes that medical mistreatment of racialized women continues today, with forced sterilization, coercive implementation of intrauterine devices (IUD), substandard delivery room care and outcomes, and exploitative medical procedures still rampant in the reproductive medical community (2020, 56-57, see also Goodrow 2019). Histories of abuse have led to biomedical distrust amongst women of colour, who are then further distanced from nuclear family ideals through their disconnection from the reproductive care offered to white women (Davis 2020). I maintain that in NA social constructions of gender and race are inseparable from the construction of family and reproduction.

The nuclear family model continues to be largely mythological; most NA families do not conform to its particularities (Ryan and Moras 2017, 580). However, nuclear family imaginaries continue to subject women to tense networks of meaning concerning womanhood, motherhood, and reproduction (Stoler 1984, 634; Lewin 1983, 193). As such, clear resistance to the nuclear family model is often perceived as a radical challenge to the power structures that sustain the NA nation-state (Ryan and Moras 2017, 580; Fassin 2011). Lesbian and single mothers have been identified as individuals who, because of an absence of father in their family-building, signify that radical resistance to this model is possible (Ryan and Moras 2017, 581). Indeed, the kinship practices of individuals with diverse sexualities and genders so typify unique family formation that cisgender, heterosexual families may be viewed as ‘queered’ through processes such as the following: collectivity, which encourages collective judgement and resource sharing in the care of a child, with communities including fathers, mothers, extended family, and non-biological care-givers (Silver 2020); mutual choice among blended families, who through remarriage or re-partnering, continue to co-parent their children, affirming one another’s capacity to make decisions in the best interest of the child (Parks 2013); polyamory, defined as family and relationship structures that include more than two monogamously coupled individuals or parents (Park 2013; Flack 2009); and challenges to monomaternalism, a construct which functionally distances the biological mother from both extended mothering options, such as step-parenting, and from support networks of mothers who may arise from the strategies listed above (Parks 2013). Despite the tendency to

synonymize 'queered' and 'radical' family structures, in practice lesbian mothers frequently reproduce the narratives, symbols and imageries that uphold the nuclear family model and its constituting power structures.

North American Lesbian Motherhood

Multiple scholars have approached lesbian motherhood with the expectation of locating subversion (Lewin 2016, 599). However, ethnographic research has found that the nuclear family model maintains its prevalence in lesbian family practices. Lewin's seminal ethnographic work with lesbian mothers suggests that the tendency to conform is likely grounded in the fundamental pressures exerted on all NA women (1993, 192).

Lewin's longitudinal research reveals that lesbian motherhood does not differ starkly from heterosexual motherhood; ultimately, both are constrained under contemporary patriarchal expectations surrounding proper femininity and gendered performance (1993, 17 and 192). However, Lewin elucidates that lesbian women's additional marginalization likely creates an exaggerated response to perceived and real pressure to properly perform motherhood (1993,191–192). This aligns with contemporary scholarship that elucidates that 'queered' family formations are increasingly practiced by heterosexual couples whose privilege affords them more space to subvert social norms (Park 2019, 154; Silver 2020, 3; Tallbear 2018, 152–153). Like lesbian mothers, Black and Indigenous women of colour are often assumed to be at the forefront of decolonial familial subversion (Silver 2020, 5–6; Tallbear 2018). However, several studies illustrate that many lesbian women of colour reproduce gendered familial structures even more intently than their white counterparts (Reed et al. 2011).

Lewin posits that multiply-minoritized lesbian women may be more likely to conform to narratives such as the performance of constructed familial gendered roles to protect themselves from further patriarchal and heterosexist speculation (Lewin 1993, 2017; Herbrand 2018, 315–316). However, her study does not address subject positions that are additionally marginalized under colonial, capitalist, patriarchal, and neoliberal institutions. Multiply-minoritized individuals are theorized, under the minority stress model, to experience both external, environmental stressors such as poverty or poor healthcare, and internal reactive stressors, such as internalized racism, or the internalized belief that ideal motherhood is less accessible to them (Cyrus 2010, 196). Multiply-minoritized individuals include those with intersecting subjugated identity markers, such as queer, low income, disabled, Black, Latino, Indigenous, or otherwise racialized. Multiply-minoritized individuals face unique and compounded exclusions from power, access, and equity under dominant, hegemonic institutional and structural norms (Cyrus 2010, 196–7). For multiply-minoritized lesbian mothers, research has shown that strict behavioural expectations for parenting are established under the gaze of heteronormative speculation. Beneath that gaze racialized, low-income, and disabled bodies, who risk further subjugation by subverting normativity, are offered fewer choices and experience more governance as well as stricter internal-external controls (Reed et al. 2011, 752; Pande 2021, 337; Roberts 2009, 798).

Reed and colleague's 2011 ethnographic study with Black, low-income, young, lesbian mothers at a drop-in center for at risk-youth in the United States exemplifies this notion. They explain that this group of mothers strongly align themselves with traditional NA nuclear family formation. In fact, these mothers adamantly police themselves and others to adhere to the roles: "femmes" "stemmes" and "babies' daddies" or "studs" (Reed et al. 2011, 757). Each of these roles mark proximity to ideal motherhood, which is dependent on levels of normative femininity (Reed et al.

2011, 757). Ideal motherhood is a location reserved for mothers, who are nearest to the nuclear family and normative cisgender femininity. Reed and colleagues elucidate that

> Black lesbian communities often have gender identity norms that play a role in organizing sexual and romantic life…There may be pressure for some to bear children, whereas others may be condemned…individual reproductive decisions are culturally mediated and influenced by social control and support. (Reed et al. 2011, 752)

Each family role present in this community context is intimately bound to the relationships that the women have to men, who provide them with sperm. Within the community, sex with men is viewed as violating norms associated with both sexuality and gender; however, access to medically assisted ART is limited as a result of the women's marginalized socioeconomic status (Reed et al., 759-7610. Therefore, sex with men, while most often necessary for pregnancy, is viewed disparagingly and constructs new sets of social norms that may be violated (Reed et al., 761). Ultimately, without access to the anonymity provided by ART these relationships are surveilled more intently (Reed et al. 2011, 758).

Due to the necessity of hegemony under colonial, patriarchal neoliberalism, when one group of women are granted access to dominant locations within motherhood, others are further marginalized by the mechanisms and institutions that grant this admittance (Lewin 2016 604; Goodrow 2019, 141; Davis 2020, 57). ART is one of these mechanisms—one that many upper-middle-class, white lesbian mothers depend on to build families (Ryan and Moras 2017, 581). While attempting to fit into normative roles to avoid speculation and subjugation, these mothers often unconsciously reproduce constructions of biological race, dichotomous familial gender roles, and modified eugenicist thought.

ARTIFICIAL REPRODUCTIVE TECHNOLOGIES: BIOPOWER, RACE, CLASS, AND ABILITY

The Bio-Politics of Artificial Reproductive Technologies

Lesbian women in otherwise dominant subject positions are given the option to somewhat emulate prevailing heteronormative patriarchal ideals when using ART. Simultaneously, multiply-minoritized individuals are often symbolically and materially excluded from access to the framework of ideal motherhood that ART affords their more privileged peers (Ryan and Moras 2017, 593). However, across intersecting identity markers, many lesbian women who use ART are responding to normalizing structural pressures that are intensified by their minoritized sexual identity (Lewin 1993, 192; 2016; Ryan and Moras 2017; Herbrand 2020). As such, white, middle-class, able-bodied lesbian mothers enact traditional family and gender roles within a cultural context that exerts excessive pressure for the performance of ideal motherhood and womanhood (Lewin 2017; 1993, 192; Herbrand 2018, 318–319.) ART acts upon these insecurities and provides a limited set of options that sustain dominant colonial, patriarchal and neoliberal family-building narratives.

Michel Foucault's theory of biopower delineates the ways that the body is politicized and controlled (1984a, 262). Medical interventions into reproduction are a clear example of a bio-political mechanism that regulates the surveilled body, as sex and sexuality are crucial to the creation and maintenance of power structures (262 and 266). The body, blood relations, and kinship are all regulated and normalized to create and maintain power hierarchies (266–268). Therefore, within bio-political discourse, ART can be viewed as mechanisms of control that are co-constitutive

with the deeply personal and political sites of the body and kinship.

ART are presented as radical interventions into reproduction and parenthood that can ensure specific medical outcomes, produce normative biological family aesthetics, and provide motherhood to individuals who might not otherwise become pregnant. (Ryan and Moras 2017, 581; Goodrow 2019, 138; Roberts 2009, 786). However, in alignment with the biopower theoretic, critics of ART point out that in the process of meticulously designing motherhood, normative cultural narratives that subjugate and oppress are necessarily reproduced (Ryan and Moras 2017, 581; Goodrow 2019, 138; Roberts 2009, 786). Lesbian mothers using ART are often navigating pressures to conform to heteronormative family ideals. Under such scrutiny "racial matching", through which gamete selection ensures that children look like both of their parents, becomes imperative (Pande 2021, 336). Ryan and Moras explain that parents pursue "matching" because "[they] know[s] that a lack of family homogeneity is used to deny the legitimacy of same-sex families" (2017, 585). Because ART is most accessible to upper-middle class, white couples or single parents, their whiteness becomes naturalized and concealed within ART (Davis 2020, 57). White intending mothers often fail to recognize themselves as a part of racial constructs and are therefore less likely to acknowledge racial matching as an activation of racial representation (Ryan and Moras 2017, 585; Fassin 2011, 420). A lack of necessitated acknowledgement of race amongst white intending parents is co-constructed with ART discourses that present whiteness as the default through advertising, the nuanced rhetoric of racial and shade matching, and decreased options for people of colour pursuing ART (Pande 2021). This both reifies dominant colonial racial hierarchies, which make whiteness invisible and beneficial, and has material consequences for lesbian women of colour pursuing ART and parenthood more broadly.

Artificial Reproductive Technology: Race and Class

ART has become a transnational industry with providers in the global South offering less expensive treatments than those in the global North (Pande 2021, 335). As such, reproductive travel has proliferated, and global neoliberal power structures are reproduced through the industry (335). Pande's mobile ethnographic study found that within the transnational reproductive technologies industry, ART "reproduces the desirability of whiteness" (335). Pande observed that a desire for racial matching from intending parents from the global North increases the demand for eggs from white South African women who provide whiteness at a lower cost than donors from the US (338). Often gamete banks that provide South African eggs and sperm are in India or Southeast Asia (338–339). Production of whiteness in the transnational reproductive industry is reactive to the desires of its most affluent customers: those from the global North importing biological kinship [2] from sending countries.

Choosing gametes for the purpose of parent-child aesthetic matching might be viewed as harmless; however, Ryan and Moras have shown that often white mothers do not recognize that by choosing white donors they are strategically selecting their prospective child's race (2017, 581). Like Ryan and Moras, I do not suggest that white women should opt to have children of colour. Rather, I contend that an uncritical approach to ART discourses, which naturalize and privilege whiteness as unmarked or a default, must be challenged (588). Fassin elucidates that "[r]acial embodiment does not only concern those who had the

[2] Biological kinship denotes the degree to which two or more species or humans share genetic relatedness. Within ART, biological kinship between parent and child may be achieved over and above, for example, adoption.

intimate conviction of the reality of …discrimination" (2011, 421). Naming whiteness as a construct is imperative to understanding the ways that technologies as mechanisms of control can reproduce colonial racism (Fassin 2011, 421; Foucault 1984a, 268–269). The link between race and body is not natural, but naturalization of a dominant norm enables further control and contributes to oppressive, hierarchizing policy and practice (Fassin 2011, 421). Normalization and naturalization of dominant subject positions are central to the harms associated with ART.

Because of an increased demand from white parents desiring extremely specific matches in heritage, Black and Latino gametes in ART have become sparse (Ryan and Moras 2017, 573). As such, women of colour are presented with restricted options and are subjected to what Dana-Ain Davis calls "obstetric racism" within and outside of NA (2020, 58; Pande 2021, 336). While transnationality has perhaps made ART more accessible to less wealthy individuals, these technologies continue to be expensive and largely tailored toward the white middle-class. In Canada for instance, the average cost of a single round of invitro fertilization is twenty thousand dollars, while in India the cost ranges from approximately eight to fifteen thousand dollars (Novia Scotia Government; CNY Fertility). Intending parents who do not use ART often face criticism for their use of alternative, less expensive methods, such as intercourse with men or at home donor insemination. This solidifies a hierarchy of parenthood grounded in privileged or oppressed class positionality (Reed et al 2011, 762; Davis 2020, 57). In many ways, then, pregnancy norms become symbolically associated with class-status.

Artificial Reproductive Technology and Disability

One of ART's functions is to inform parents of potential disability. Consequently, disability activists have identified ART's capacity to promote contemporary eugenicist practice (Goodrow 2019, 144). Eugenics is a branch of pseudo-scientific thought that emerged from the novel study of genetics and in response to the political crisis of booming populations in the nineteenth and early twentieth centuries (Goodrow 2019, 139–140). The principal assumption underlying eugenics is that certain portions of the populace, namely those in dominant hegemonic positions, are more genetically fit and should therefore form the reproductive base of the population (Goodrow 2019, 139–149). Goodrow uses the concept of positive and negative eugenics to illustrate how repressive reproductive technologies, such as subsidized long-acting contraceptives or sterilization targeted toward women of colour, women accessing welfare, and incarcerated women are contemporary forms of negative eugenics (Goodrow 2019, 144). Simultaneously, white, upper-middle class women are offered reproductive technologies that encourage high fertility and provide insight about potential disabilities that may lead to selective abortion (Goodrow 2019, 144 and 151). While it is not inherently harmful to offer women the option to screen for disability or to increase their fertility, uneven access to these technologies reproduces hierarchies that facilitate reproductive choice only for those with specific positionalities (Goodrow 2019, 144). Ultimately, akin to past eugenicist politics, certain women's bodies are safeguarded while others are used, constrained, and devalued (Pande 2021, 344). ART was founded within a cultural context that has a violent history of reproductive control that impacts all individuals. This control is particularly evident for those whose sexuality, race, gender, or ability divert from the dominant norm.

ARTIFICIAL REPRODUCTIVE TECHNOLOGIES AND LESBIAN MOTHERHOOD

Individual, white lesbian mothers are not central to the issues outlined above. Nevertheless, as a queer, white woman, I self-reflexively believe that we must recognize and name the privilege associated with our whiteness. This might be encouraged by reflecting on the ways that discrimination against our sexuality places us in a precarious space within reproductive narratives. ART as a mechanism of control over the body may utilize those insecurities, complicating resistance and reflection. Whiteness is so naturalized and demarked within our cultural context that it is often uncritically assumed that the accessibility offered to white individuals with intersecting subordinated identities is natural or normal (Fassin 2011; Foucault 1984a). However, racial embodiment is not natural. Rather, all privileged and oppressed positionalities are contextually specific and historically, socially, and culturally constructed (Fassin 2011, 420). Reproduction is a site wherein embodied experiences may be imbued with symbolic social and material meanings. While these meanings are contextual, cultural, and performative, gender, race and ability are often viewed in reproductive narratives as natural, innate, and biological (Herbrand 2018 311). ART discourses typify the notion that idealized forms of human reproduction are not socially meaningful and are rather a matter of objective fact.

Ideal performances of womanhood are tied to motherhood. Within this intersection a hierarchy of ideal motherhood emerges (Reed et al. 2011, 751). White lesbian women encounter a choice wherein, by perpetuating the norm, they may be granted access to nearly ideal motherhood and thus womanhood. Here, they may be placed just below heterosexual, white, feminine, coupled mothers (Reed et al. 2011, 751). Therefore, in pursuit of the social support that has historically been denied to lesbian mothers, white lesbian mothers may perpetuate other idealized norms.

While ART does represent a step forward for lesbian women who wish to pursue motherhood, it is imperative that white lesbian women ask exactly who benefits from this technology. Critical engagement with ART as a technology that reproduces hegemony on lines of race, ability, and class is crucial to dismantling the structures and systems that continue to subjugate most women while privileging few. Processes of critical engagement are as numerous as the individual positionalities that approach them to influence change in themselves and others. However, for white individuals, critical engagement with constructs embedded in colonial patriarchy demands the recognition that whiteness both exists and awards privilege (Fassin 2011). Challenging the presuppositions embedded in ART is a step toward dismantling myths surrounding family and motherhood and creating space for new kinds of decolonized kinship practices that are rooted in fluidity, relationality, and openness (Tallbear 2018, 146; Silver 2020). By evaluating NA kinship myths and the mechanisms that support them, new forms of family may emerge. Here, white lesbian mothers have a unique opportunity to critically deconstruct the concept of ideal motherhood by naming whiteness as their access point.

CONCLUSION

By evaluating ethnographic research on lesbian motherhood and the proliferation of ART through intersectional and critical-race frameworks, I have asserted that ART functions as a bio-political mechanism, active in mediating the pursuit of ideal motherhood. I argue that white, lesbian mothers unquestioning use of ART perpetuates: the gendered myth of NA ideal motherhood within the nuclear family; reifies social stratification on the lines of race, class, and ability; and constrains new forms of kinship that may challenge reproductive myths maintained by and embedded

within existing power structures. This article recognizes that kinship, and its many expansive significations across cultures and subject positions, functions as a unique site of control when wielded by dominant hegemonic structures, and that when reclaimed might redefine family-building as a site of positive power and coalition building toward a more just future (Silver 2020, 2). Family diversification and queered kinship structures may functionally unveil, and question dichotomized gender roles, increasing the roles available to all individuals in a society. Simultaneously, expanding social perceptions of kinship would diminish the persistent pressure of achieving ideal motherhood for privileged, multiply-minoritized, queer and heterosexual mothers alike. Here, interventions into bio-political technologies become imperative for pursuing kinship meanings built by and for those who are actively building family.

I have attempted to reflexively posit that white lesbian intending mothers are uniquely positioned in this discourse, as their marginalized sexuality places ideal motherhood slightly out of reach, while their whiteness brings it slightly closer (Reed et al. 2011, 751; Davis 2020, 57). ART functionalizes white, lesbian women's insecurities by exerting pressure on them to conform to ideal motherhood to avoid heterosexist and patriarchal speculation and gain social support (Reed et al., 2011). Thereafter ART, like other discursive mechanisms of control, skillfully demark, naturalize, and normalize privilege, while purporting to produce objective scientific rather than socially constructed meanings (Foucault 1984a, 262; 267). I contend that due to their positionality as both privileged and marginalized in ideal motherhood, white lesbian women are in a unique position to critically engage and challenge the harmful social stratifications that ART perpetuates, while potentially creating space for new and diverse family meanings.

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REVIEW ARTICLE

Tooth Wear Age Estimation of Ruminants from Archaeological Sites

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ABSTRACT

The teeth of ruminants (cud-chewing herbivores) can be used to estimate age. Tooth wear age estimation is an especially valuable method in archaeological research because it is non-destructive, efficient, and is adaptable to multiple species, which provides effective results. The objective of this paper is to review tooth wear age estimation approaches taken with a focus on cervid (deer) and caprine (sheep and goat) mandibles. I discuss the process of dental attrition involving ruminant chewing, digestion, and feeding behaviour, as well as factors that affect the rate of wear including individual and population variance. The approaches to tooth wear age estimation have been divided into three overarching categories: the Crown Height Method, the Visual Wear Pattern Method, and the Wear Trait Scoring Method. These approaches are all non-destructive and require similar assumptions about the regularities of tooth wear. Each involves different levels of accuracy, ease of use, efficiency, and applicability to archaeological mandibles. This paper highlights the strengths and weaknesses for these approaches and explains that these various methods reviewed are each better suited to different research situations. Taken together, tooth wear age estimation is a valuable tool that zooarchaeologists employ to reconstruct age-based demographic profiles of animal remains recovered from archaeological sites, illustrating how people interacted with and used them.

Keywords: zooarchaeology, tooth wear, dental attrition, age estimation, ageing, Cervidae, Caprine

INTRODUCTION

Estimating ages of animals from archaeological sites using dental remains has proven essential to understanding how people and animals interacted in the past (Klein and Cruz-Uribe 1983; Gifford-Gonzalez 2018; Reitz and Wing 2008; Russell 2012; Stiner 1990). These age estimations can be used to reconstruct demographic profiles that can inform on past hunting strategies, domestication practices, and other aspects of human-animal interactions (Klein and Cruz-Uribe 1983; Gifford-Gonzalez 2018; Reitz and Wing 2008; Russell 2012; Stiner 1990). Tooth wear age estimation is one of the three most frequently applied ageing techniques in zooarchaeology because this method is efficient, non-destructive, and works for age adult individuals of many species (Twiss 2008).

The other two often-employed ageing methods are tooth eruption sequences and cementum annulation. Tooth eruption sequences are used to estimate the age of younger individuals and requires knowing the timing and order of deciduous and permeant dentition eruption (Hillson 2005, 229–37). The age at which deciduous teeth erupt, are lost, and the eruption of permanent teeth follow a biologically determined schedule specific to a given species or population (Hillson 2005). Variation of normal development and eruption

sequences must be considered between different individuals, populations, sexes, environments, and with biological stress (Miller 1972; Spiess 1979, 77; Tomé and Vigne 2003, 172).

While tooth eruption ageing is limited to animals that died before their permanent dentition came into place, cementum annulation can be applied to older individuals. Cementum annulation examines annually deposited bands of cementum on tooth roots, which are microscopically observed and counted in cross-section (Aitken 1975; McEwan 1963; Gifford-Gonzalez 2018, 127–29). More accurate than tooth wear age estimation, this method is applied as a close substitute for known-aged specimens (Pérez-Barbería, Carranza, and Sánchez-Prieto 2015; Miller 1972). Partial or complete destruction of one tooth is necessary to prepare a cross-section for this method (Pérez-Barbería, Carranza, and Sánchez-Prieto 2015; Miller 1972). Irreversible destructive methods like this are often avoided or not permitted when others exist that produce similar results, especially in museum curated collections that work to preserve these remains (Gifford-Gonzalez 2018, 129). Biological processes that lead to inaccurate results when using cementum annulation include missing or extra annuli lines that manifest during irregular times of bodily stress and resorption of cementum during life (Pérez-Barbería et al. 2014, 186; Reitz and Wing 2008, 76–77; Spinage 1973). At older ages, deposited layers are thinner, making the cementum annuli bands narrower and harder to read (Dudley Furniss-Roe 2008; Spiess 1979, 68–69; Turner 1977). This age varies between species. For example, narrower bands of cementum deposited in bighorn sheep (*Ovis canadensis canadensis*) teeth older than eight years lead to a significant discrepancy between cementum age and known age (Dudley Furniss-Roe 2008; Turner 1977).

Although tooth wear ageing methods are not as accurate as the two described above, they are especially useful for mandibles with fully erupted dentition while also being a non-destructive form of analysis (Reitz and Wing 2008, 174; Steele and Weaver 2012, 2329). Compared to cementum annulation, tooth wear ageing is easy to learn, takes considerably less time to complete, does not require destruction of irreplaceable specimens, is inexpensive, and does not require specialized equipment (Reitz and Wing 2008, 174; Steele and Weaver 2012, 2329). The premise of this method is that as animals get older their teeth get progressively worn on the occlusal surface (DeMiguel et al. 2016; Spinage 1973). Chewing causes this occlusal wear which begins as each tooth erupts past through the gum and meets an opposing occlusal tooth (Hillson 2005, 214). Thus, correlating the degree of occlusal wear on teeth to the amount of time an individual was alive and eating is possible (Hillson 2005).

Tooth wear age estimation is more efficient and easier to learn than cementum annulation and can be adapted to additional species with some work and access to known-age specimens (Gifford-Gonzalez 2018; Lyman 2017; Miller 1974; Spinage 1973). This method has been developed for and applied to age a variety of mammals in zooarchaeology (Bowen et al. 2016; Dudley Furniss-Roe 2008; Grant 1982; Greenfield and Arnold 2008; Halstead 1985; Hambleton 1998; Klein and Cruz-Uribe 1983; Lubinski 2001; Morrison and Whitridge 1997; Mutze et al. 2021; Pasda 2009; Payne 1973; 1987; Pike-Tay, Morcomb, and O'Farrell 2001; Steele and Weaver 2012; Tomé and Vigne 2003; Twiss 2008; van den Berg, Loonen, and Çakırlar 2021), in wildlife management (Brown and Chapman 1990; 1991; Høye 2006; Lowe 1967; Miller 1972; 1974; Pérez-Barbería et al. 2014), and in veterinary studies (Aitken 1975). For mammals, mandibles and teeth survive well against taphonomic processes, and are therefore more likely available for archaeological research compared with fragile maxillae (Gifford-Gonzalez 2018, 125; Pasda 2009; Spiess 1979, 77; Winkler and Kaiser 2015).

Mandibles are often considered over maxillae because they are easier to work with, more robust to damage, and mandibular teeth are more likely to remain socketed (Hillson 2005, 231). Most ruminant tooth wear studies are made for lower (mandibular) dentition (Hillson 2005).

The purpose of this paper is to explore how previous research has approached tooth wear to estimate ages of ruminants (large, cud-chewing herbivores) while focusing on its utility in zooarchaeological contexts. The scope of this paper is on research surrounding the Cervidae family (deer) and Caprinae subfamily (sheep and goats), but concepts surrounding tooth wear studies apply generally to all ruminant teeth. This paper analyses three methods used to investigate ruminants. Before evaluating these methods, I first summarize the processes affecting the rate of wear and contributing to variation within individuals, between individuals in a population, and between populations. Second, I establish the assumptions about tooth wear that are necessary when attempting to apply this approach as a meaningful indicator of age. Third, this paper provides a comparison and discussion of several tooth wear ageing methodologies grouped into three overarching categories: the Crown Height Method, the Visual Wear Pattern Method, and the Wear Trait Scoring Method. This comparison demonstrates how each method works, their strengths and limitations, accuracy, ease of use, and how suitable they are for ruminant mandibular remains from archaeological contexts. This review conveys that there are a variety of tooth wear ageing techniques available to researchers, which here are divided into three overarching methodological categories. There is no 'one size fits all' approach; each of these approaches carries advantages and disadvantages rendering them useful in different situations

RATE OF WEARL VARIATIONS AND ASSUMPTIONS

Dental attrition is ultimately the product of food and other ingested matter chewed over a lifetime; the number of years an individual lived is only indirectly related (Spinage 1973, Reitz and Wing 2008, 174). Cervids and bovids (antelopes, bison, cattle, gazelles, goats, sheep, and relatives) have molar and premolar teeth that are adapted morphologically as two parallel, crescent-shaped rows for grinding plant matter in a side-to-side chewing motion (Hillson 2005; Pérez-Barbería, Carranza, and Sánchez-Prieto 2015; Winkler and Kaiser 2015). Figure 1 shows a reindeer (*Rangifer tarandus*) M_3 (third molar) that illustrates an example of this morphology. Ruminants depend on symbiotic microorganisms to break down and ferment vegetation as part of their digestion process (Hillson 2005; Pérez-Barbería, Carranza, and Sánchez-Prieto 2015; Winkler and Kaiser 2015). By regurgitating and re-chewing food, the particle size of vegetation is reduced, and the process of digestion works more effectively (DeMiguel et al. 2016; Loe et al. 2003; Hillson 2005, 132–35). Continual chewing causes the occlusal surface of ruminants' teeth to wear down where upper (maxillary) and lower (mandibular) occlusal surfaces contact. The

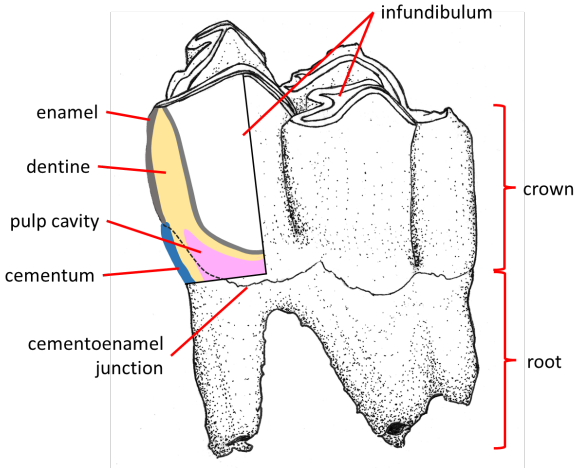

FIGURE 1–*Tooth morphology of a M_3 showing dentine, enamel, cementum, pulp cavity, root, crown, cementoenamel junction, and infundibulum (Created by author)*

enamel is then eroded, exposing the dentine and infundibula beneath (DeMiguel et al. 2016; Hillson 2005, 18; Janzen, Balasse, and Ambrose 2020; Winkler and Kaiser 2015). This process begins as soon as a tooth has erupted and continues until the tooth has been worn to the root or is lost (Hillson 2005, 212; Payne 1973, 285). Therefore, because teeth erupt at different times, each one has a different starting point (Hillson 2005, 212; Payne 1973, 285). For example, the M_1 (first molar) starts to wear and is exhausted sooner than the M_3, making the M_3 a better measure for older individuals (Spinage 1973).

Several factors affect the rate of tooth wear (see Figure 2). Differential diet is perhaps the greatest variable factor for ruminants. Simply put, the courser the food, the faster the wear on the occlusal surface (Pérez-Barbería, Carranza, and Sánchez-Prieto 2015; Skogland 1988). Softer plants like grass, lichen, and soft leaves cause slower wear than tougher leaves, twigs, and branches (Gifford-Gonzalez 2018, 131). Dirt or grit ingested along with grazed plants and lichens will also accelerate the rate of wear (Høye 2006, 206; Reitz and Wing 2008, 174). Increased grit is sometimes associated with overgrazing in which the animals are pulling up shorter vegetation closer to the ground (Spiess 1979, 75) with reindeer and caribou. Drier environmental conditions lead to more airborne sediment deposited on vegetation (Mutze et al. 2021). Mutze and colleagues (2021) find that sheep (*Ovis aries*) and goats (*Capra hircus*) in Egypt exhibit extremely worn molariform teeth during dry conditions. Seasonal migration between pastures or extreme seasons affects the types and qualities of forage available (Mutze et al. 2021). In reindeer, the rate of wear significantly slows during the winter months because feeding behaviours change (Skogland 1984; 1988). When their diets are restricted to relatively course vegetation such as shrubs or overgrazed, low to the ground vegetation in which sediment is also ingested, occlusal attrition accelerates (Skogland 1984; 1988). Significant environmental change within an animal's lifetime or between generations could also cause a change in foraging behaviour increasing the rate of tooth wear variability over longer periods of time (Skogland 1984; 1988).

Differences in behaviour can affect the rate of tooth wear (Hillson 2005; Reitz and Wing 2008; Sten 2004). Discrepancies between tooth wear on right and left mandibles have been observed in cattle (Sten 2004, 134). However, in archaeological contexts assessing which side an animal preferred to chew with is rarely possible because mandibles from a single animal are rarely together in situ and each element may represent separate individuals (Reitz and Wing 2008, 117–25). Hillson (2005, 214) notes that animals, too,

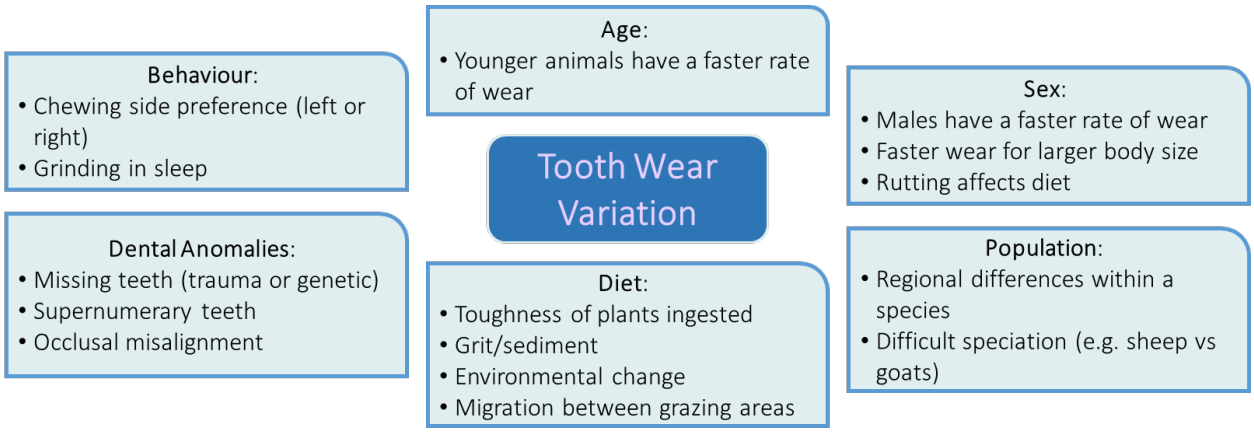

FIGURE 2–*Summary of the sources of variation in ruminant tooth wear as outlined in this paper (Created by author)*

grind their teeth while they sleep, which may be difficult to recognize osteologically.

The rate of wear also changes through various stages of an animal's lifetime (Høye 2006; Pérez-Barbería, Carranza, and Sánchez-Prieto 2015). Younger ruminants' teeth wear at a faster rate while their molariform cusps are only minimally worn and still relatively sharp (Høye 2006; Pérez-Barbería, Carranza, and Sánchez-Prieto 2015). Alternatively, the occlusal surfaces on teeth of older animals are worn flat and are made less effective at grinding food, requiring more energy to digest food (Høye 2006; Pérez-Barbería, Carranza, and Sánchez-Prieto 2015). As a result, older animals may experience a deterioration in health related to poor diet that Skogland (1988) observes in reindeer and that Pérez-Barbería, Carranza, and Sánchez-Prieto (2015) and Høye (2006) describe in red deer (*Cervus elaphus*).

Another source of variation on teeth within a population is the effects of sexual dimorphism on dentition and diet. Male ruminants' teeth typically wear down faster than females' (Twiss 2008, 343; van den Berg, Loonen, and Çakırlar 2021, 9; Høye 2006, 210). The contrast in rate of wear rate has been quantified for caribou (Morrison and Whitridge 1997) and red deer (Pérez-Barbería et al. 2014) using known-sex animals. Morrison and Whitridge (1997, 1097) find that while males initially wear teeth faster, by around two years of age females from the Qamanirjuaq (also known as Kaminuriak) caribou population caught up and exceed males later in life. Pérez-Barbería and collaborators (2014, 183) identify different sets of tooth wear traits and develop separate equations for whether the red deer is male, female, or indeterminate (Pérez-Barbería et al. 2014). This study finds that males' teeth are aged slightly more accurately because they wear faster (Pérez-Barbería et al. 2014). Loe and colleagues (2003) explain this phenomenon; males need greater amounts of food to fulfill greater energy expenditures (larger body size and rutting) and so dental attrition is faster. This is confirmed by a greater measured reduction in crown height on average compared with females (Loe et al. 2003). In some instances, the sex of an animal can be determined using biometrics, for example, the length of reindeer and caribou mandibles have been used to indicate whether the animal is female or male (Morrison and Whitridge 1997; Spiess 1979, 82). However, differentiating tooth wear by sex is generally possible only for modern population datasets when there is access to the recently dead bodies or, though less reliable, entire skeletons (Pasda 2009).

Dental abnormalities and pathologies are known to create irregular wear patterns. For example, Miller and Tessier (1971) record a series of dental anomalies including missing and supernumerary teeth as well as misaligned occlusion found in caribou. If one tooth is lost, the opposing tooth will continue to wear at a much slower, less predictable rate (Miller and Tessier 1971). Alternatively, they find that if extra-numerary molars or premolars (P_2 to P_4) are present, this dental addition disturbs placement within the tooth row and causes reduced attrition on the left-out tooth (Miller and Tessier 1971). When P_1 (first premolar) is present, teeth placement is not affected (Miller and Tessier 1971). The P_1 is commonly absent in ruminants. Any abnormality that alters the occlusal alignment between mandibular and maxillary dentition may result in an absence of wear on the opposing tooth or unusual wear patterning (Miller and Tessier 1971; Miller 1974). In an extreme case, Bowen and coauthors (2016, 1090–94) find that populations of fallow deer (*Dama dama*) raised in French menageries frequently show dental abnormalities, hindering age estimation for those individuals. Grant (1982, 91) also notes overcrowded teeth in domestic sheep, goats, and pigs (*Sus scrofa*) causing abnormal wear. Thus, when conducting tooth wear studies, recognizing abnormal dentition is

critical which may result in those individuals being outliers within the dataset and excluded from analysis.

Even difficult species differentiation or divergent populations of a single species can be a source of inaccuracy in tooth wear analysis. Mandibles and teeth from goats and sheep are usually aged together since the two species are very challenging to differentiate visually, despite the difference in diet, behaviour, and biology (Payne 1973, 284; Twiss 2008, 333). Similarly, modern reference populations must be used for archaeological animals with caution as there may also be considerable differences between the two, even of the same species (Salvagno et al. 2021; Klein and Cruz-Uribe 1983, 71). For a single species that covers a large geographic area, such as reindeer and caribou, there may be enough genetic variation between populations that render shared tooth wear ageing methods unreliable (Salvagno et al. 2021; Klein and Cruz-Uribe 1983, 71). For example, in their recently developed method for estimating ages of Svalbard reindeer (*Rangifer tarandus platyrhynchus*), van den Berg and colleagues (2021) caution that their Svalbard ageing scheme should not be applied to all *Rangifer* populations and devised a second, uncalibrated scheme for wider application.

All these ageing methods require a set of assumptions about the regularity of dental attrition. Keeping in mind all aforementioned sources of variation in the rate of wear (see Figure 2 for summary), the variation in tooth wear will either be insignificant, resulting in an acceptable margin of error, or that variation must be accounted for (Spinage 1973; Twiss 2008, 330; Gifford-Gonzalez 2018, 138). When analyzing archaeological animal remains, identify sources of variation from a mandible including diet, behaviour, sex, or genetic differences is rarely possible in macroscopic analysis (Spinage 1973; Twiss 2008, 330; Gifford-Gonzalez 2018, 138). Assumptions that must be accepted to apply tooth wear age estimation to a population of ruminants from archaeological sites include:

- The rate of wear happens at a predictable rate within an individual's lifespan. While possible to identify dental abnormalities and remove those as outliers, identifying changes to dental attrition such as a change in diet or behaviour by visual inspection alone is much more difficult (Twiss 2008).
- The rate of wear is assumed to be uniform across individuals within each age category within a population. One must assume there is not a significant difference between male or female, right and left chewing preference, access to different qualities of food, or differences in health and nutrition (Twiss 2008, 330–31).
- The rate of wear between populations must be approximately the same. This is especially true between the known-age reference population used to develop an ageing scheme and the population the ageing scheme is applied to (Twiss 2008).

TOOTH WEAR AGEING METHODS

This section outlines multiple approaches to tooth wear age estimation that have been developed for Cervidae and Caprinae, some of which are better suited to certain research scenarios. These methods are divided into three overarching categories: Crown Height, Visual Wear Pattern, and Wear Trait Scoring Methods. Usually, researchers can easily tell which animals are younger or older relative to one another using tooth wear (Aitken 1975; Gifford-Gonzalez 2018; Lowe 1967; Spinage 1973; van den Berg, Loonen, and Çakırlar 2021). The greatest challenge is to relate relative age to an estimation of age in years or months (Miller 1974). To do this, a collection of mandibles of the same species are needed for which the age at death is known, ideally from a comparable environment and diet (Gifford-Gonzalez 2018). Table 1 shows a summary of many tooth wear age estimation methods that have been developed including

their reference sample size, the use of known-age individuals or cementum annulation, and the age ranges represented in their reference sample. More robust results are achieved when large reference sample sizes can be obtained with a well-distributed variety of age categories present, from early stages of life to very old (Reitz and Wing 2008, 250). Known age animals are preferred instead of cementum annulation because, although cementum annulation does produce fairly accurate results, this method potentially introduces inaccuracies into the tooth wear ageing method (Aitken 1975; Lowe 1967; Pérez-Barbería et al. 2014; Spinage 1973)

The quality of known-age data is also worth considering. Most studies listed in Table 1 that make use of known-age reference collections acquired from wildlife management tracking projects that ear tag or otherwise identify individuals within their first year and have a known date of death (Bowen et al. 2016; Brown and Chapman 1990; 1991; Dudley Furniss-Roe 2008; Høye 2006; Lowe 1967; Lubinski 2001; Pérez-Barbería et al. 2014; Steele and Weaver 2012). These samples will have a known age accuracy within months, depending on the circumstances of monitoring and recording births and deaths (Bowen et al. 2016; Brown and Chapman 1990; 1991; Dudley Furniss-Roe 2008; Høye 2006; Lowe 1967; Lubinski 2001; Pérez-Barbería et al. 2014; Steele and Weaver 2012). Known-age data can also be found in farmed animals, sheep and goats for example (Greenfield and Arnold 2008; Mutze et al. 2021), or from zoos and other forms of captivity (Bowen et al. 2016). For non-domestic animals, recognising the limitations or complete unsuitability of using specimens raised in captivity is essential because those animals lived in unnatural conditions that may affect diet, behaviour, and lower genetic diversity (Bowen et al. 2016; Taylor et al. 2016). Bowen and colleagues (2016, 1090) find that fallow deer raised in historic menageries in France had greater dental attrition and more frequent pathological dental disease.

Crown Height Method

Lowe (1967) states that the first published Crown Height Method was likely developed by Eidmann in 1932 with a sample size of 58 red deer using the height of incisor crowns to estimate age (Lowe 1967). However, this early attempt shows a poor relationship between crown height and age once plotted (Lowe 1967). This method also utilizes an earlier, rudimentary Visual Wear Pattern Method in place of known-age (Lowe 1967). Modern Crown Height Methods have become much more refined with the availability of more reliable reference populations.

The Crown Height Method relies on the premise that the longer an animal lived, the shorter the dental crown will be (Klein and Cruz-Uribe 1983). Nevertheless, molariform (premolar and molar) teeth have a complex shape so a more specific instruction is required to ensure reliable measurements are taken and to mathematically relate that measurement to the length of time lived (Spinage 1976). Since each tooth is measured individually, the Crown Height Method works well with fragmented assemblages and loose teeth, potentially involving specimens in analysis otherwise excluded (Klein and Cruz-Uribe 1983, 73–76). Even so, fragmented teeth or chipped enamel cusps make a tooth unsuitable for measurement (Twiss 2008, 343). If the tooth is still in its socket, crown height may be unavailable for measurement without removing teeth and causing damage (Lyman 2017; Twiss 2008, 343). One way to avoid this is to measure using an X-Ray of the mandible as Pasda (2009, 35) does, however, this requires access to specialized equipment and a greater time commitment.

The Crown Height Method employs mathematical formulas to relate the crown height measured to an animal's age (Gifford-Gonzalez 1991; Klein et al. 1981; Pike-Tay, Morcomb, and O'Farrell 2001; Twiss 2008).

There have been several approaches that principally differ in what part of the tooth is measured and how the progression of wear over a lifetime is modelled. The Quadratic Crown Height Method (QCHM) and the Linear Crown Height Method (LCHM) differ both in the dental landmarks used in measurement (Figure 3) and in the mathematical relationship devised to estimate age (Gifford-Gonzalez 1991; Klein et al. 1981; Pike-Tay, Morcomb, and O'Farrell 2001; Twiss 2008). Moreover, researchers have developed different versions of the QCHM and LCHM and do not always measure teeth the same way or may adjust the equations. To ensure an individual is counted only once, different molars or premolars from each side must be counted separately (Pike-Tay, Morcomb, and O'Farrell 2001). For example, Lubinski (2001, 226–27) mitigates this risk by only including the first molar of pronghorn antelope (*Antilocapra americana*).

The QCHM measures crown height (*CH*) from the enamel-cementum junction to the tip of the cusp on the buccal side of the tooth on the mesial-most cusp (Figure 3a) (Twiss 2008). The estimated age for each tooth (*AGE*) is calculated using the quadratic formula below (Equation 1) from Klein and Cruz-Uribe (1983, 73–76; Twiss 2008, 331–32) as a function of the potential ecological longevity (AGE_{pel}) of the species, the age at which the tooth erupts and comes into wear (AGE_e), and the initial crown height (CH_o) before occlusal wear occurs (Klein and Cruz-Uribe 1983; Twiss 2008). Age can be calculated in years or months, so long as the units of time are consistent. Twiss (2008) assumes potential ecological longevity to be 10 years, and so age classes are each one year (one tenth of the AGE_{pel}). There are a couple of flaws. This approach requires an estimate of the full crown height before wear, which is not directly observable (wear begins before the tooth has fully erupted) and AGE_{pel} does not account for an animal living beyond the time one of its teeth wear to zero (Pike-Tay, Morcomb, and O'Farrell 2001, 156; Steele and Weaver 2012, 2331; Twiss 2008, 333–34).

(1) QCHM:

$$AGE = AGE_{pel} - \frac{2\left(AGE_{pel} - AGE_e\right)CH_o}{\boldsymbol{CH}} + \frac{\left(AGE_{pel} - AGE_e\right)CH_o^2}{\boldsymbol{CH}^2}$$

Steele and Weaver (2012) test and improve upon the QCHM finding that the original (see Equation 1) underestimates the ages of Montana elk (*Cervus elaphus*) using P_4 (fourth premolar), M_2 (second molar) and M_3 when tested on 226 known-age individuals. Instead, they modify the equation (Equation 2) to better reflect the rate of wear at different life stages and performs significantly better (Steele and Weaver 2012, 2333). They replace AGE_{pel} with AGE_{tpl}, the age at which the crown height of the specific tooth type reaches zero and the exponent of two is replaced with variable *m* (Steele and Weaver 2012, 2333).

(2) $Modified\ QCHM$:

$$AGE = \left(AGE_{tpl} - AGE_e\right) \times \left(\frac{CH_0 - \boldsymbol{CH}}{CH_0}\right)^m + AGE_e$$

The LCHM measures crown height (*CH*) differently, quantifying the distance between the bifurcation of the root to the tip of the cusp on the lingual side of the tooth's mesial-most cusp (Twiss 2008). A measurement for the basal crown breadth (*CB*) is also taken (Figure 3b) (Twiss 2008). While the enamel-cementum junction for the QCHM may be accessible above the socket, the LCHM requires access to the tooth root and the tooth to be fully removed from the mandible (Twiss 2008). The relationship between age, crown height, and basal crown breadth is expressed as a linear equation below (Equation 3) from Twiss (2008, 332). The estimation of age for a single tooth, AGE_i, is a function of the animals predicts maximum

age ($AGEf_i$), the age at which the tooth erupts and comes into wear ($AGEe_i$), the crown height before wear begins (CH_{AGEmax}) and the basal crown breadth before wear begins (CH_{AGEmax}) (Twiss 2008).

(3) LCHM:

$$\text{AGE} = -\frac{(AGEf_i - AGEe_i) \times \boldsymbol{CB} \times CH_{AGEmax}}{\boldsymbol{CH} \times CB_{AGEmax}} + AGEf_i$$

Morrison and Whitridge (1997) are also successful in applying a linear regression formula to crown height for caribou. In their study, Morrison and Whitridge include caribou that were cementum aged with known sex to determine the relationship between M_1 crown height and age for males and females, creating a linear regression formula for each (Morrison and Whitridge 1997). This method also measures crown height differently (Morrison and Whitridge 1997). Crown height is measured for both lobes of the tooth from the cementoenamel junction to the occlusal surface on the buccal side and the average between the two lobes is used (Figure 3c) (Morrison and Whitridge 1997).

The choice between using QCHM or LCHM in different research contexts depends largely on which better models the changing rate of tooth wear over a lifetime for the population and/or species in question. The variable degrees of success in applying each type of regression equation and measurement approach for different species implies that for researchers to confirm which equation is most applicable to their research is essential, especially concerning species. Twiss (2008) carries out a comparison of the two Crown Height Methods for sheep and goat teeth from Çatalhöyük in Anatolia and finds better results using the QCHM. Although accuracy could not be directly tested without known-age data, the LCHM consistently does not produce any age estimates over four years old, in contrast to the results from the QCHM and Payne's (1973) method (described below) that went as high as more than ten years, suggesting a discrepancy results from the LCHM estimates.

Alternatively, Gifford-Gonzalez (1991; 2018, 136–37) finds that QCHM underestimates ages of eight-year-old bison (*Bison bison*) by up to 40 months compared with known-age individuals, and that the LQHM performs better for this species. The LCHM, as

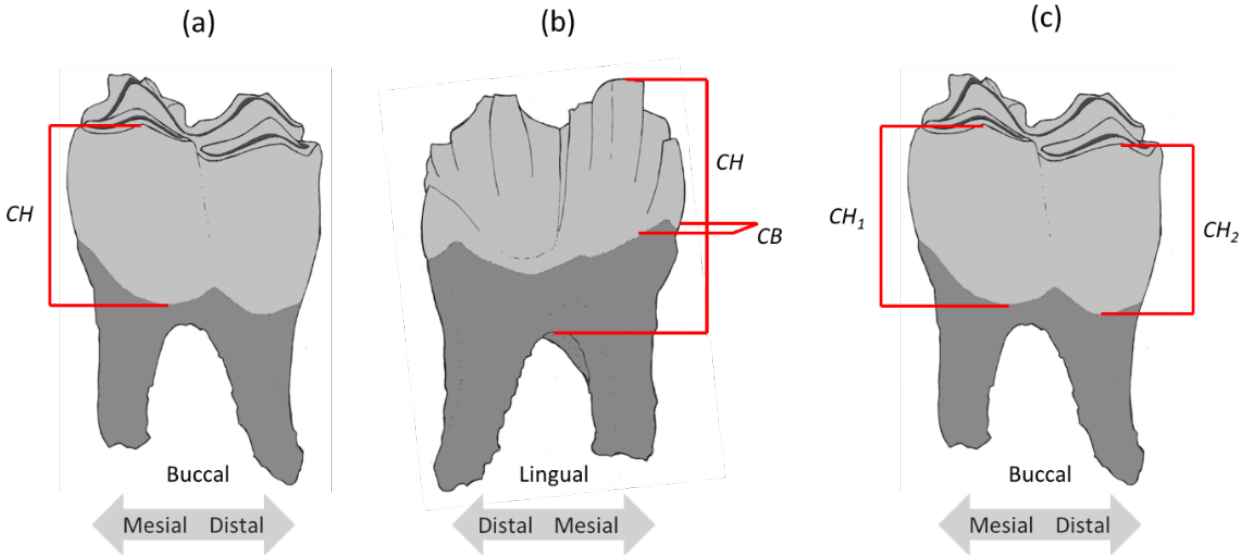

FIGURE 3–*Three crown height measurements on M_1 tooth (Rangifer tarandus) using (a) QCHM (Klein and Cruz-Uribe 1983; Steele and Weaver 2012; Twiss 2008), (b) LCHM (Twiss 2008), and (c) QCHM or LCHM (Morrison and Whitridge 1997; Pike-Tay, Morcomb, and O'Farrell 2001 (Created by author)*

defined by Twiss (2008) requires a measurement of the basal crown breadth instead of estimating the initial crown height. However, Gifford-Gonzalez (1991, 59; 2018, 137; see also Twiss 2008, 343) states that because basal crown breadth is not a useful proxy for the unworn crown height for bovids or reindeer, the QCHM is more suitable for these animals. For shorter-crowned animals like caribou and reindeer, the lesser annual decrease in height may make measurements less precise (Gifford-Gonzalez 1991, 59; 2018, 137; Morrison and Whitridge 1997; Twiss 2008). Qamanirjuaq caribou M_1 crowns shorten by less than 1mm per year, leaving little margin for error (Morrison and Whitridge 1997, 1098). In examining the same caribou collection, Pike-Tay, Morcomb, and O'Farrell (2001) caution that for older ages, when the slope of the quadratic regression formula is near horizontal, the QCHM for this short-crowned species is less reliable as an ageing method. In contrast, high-crowned bovids will have a greater measurable loss of crown height per year (Hillson 1992; 2005). Thus, the performance of Crown Height Methods appears to be dependant on the species and/or population (Hillson 1992; 2005).

Visual Wear Pattern Method

Unlike the Crown Height Method that considers wear to be the loss in dimensional height, the Visual Wear Pattern Method relies on the changing appearance of the occlusal surface as crown height diminishes. As teeth wear, enamel is removed exposing the dentine underneath (DeMiguel et al. 2016; Greaves 2012; Hillson 2005). A cross-sectional pattern of dentine and enamel is revealed and, because dentine is softer and erodes faster than enamel, the cusps take on a concave topography (Gifford-Gonzalez 2018, 131). As crown height is depleted, the wear pattern changes and can be applied to estimate age (Gifford-Gonzalez 2018, 131).

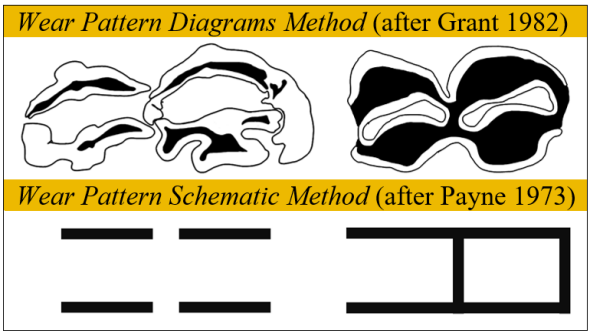

FIGURE 4–*Comparative examples of M_2 from Rangifer tarandus at different stages of wear to illustrate the difference between Grant-style illustrations with Payne-style schematic representations of wear patterns (Created by author)*

There are several approaches that this paper classifies as Visual Wear Pattern Methods that are further categorized into photographic, illustrated, and schematic approaches. To visually record tooth wear patterns using photographs, a series of known-age mandibles are first chosen that adequately represent a full range of tooth wear patterns and eruption sequences (Aitken 1975; Lowe 1967; Miller 1974; 1972; Pasda 2009). Mandibles are ordered from least tooth wear, ideally including early eruption stages, to most wear with which one can estimate ages of animals relative to the reference photos (Aitken 1975; Lowe 1967; Miller 1974; 1972; Pasda 2009). Miller (1974) published a collection of mandibular wear photos from Qamanirjuaq caribou organized by view (occlusal and buccal), age in months, and sex for comparison. Pasda (2009) has produced a similar resource for Sisimiut reindeer (*Rangifer tarandus groenlandicus*) from Greenland, as well and Lowe (1967) for red deer from Rhum, Scotland, although neither is as extensive. The utility of this type of reference depends on the quality of the photos and how they are reproduced.

Aitken (1975) undergoes a similar project to age roe deer (*Capreolus capreolus*). Instead of photos, a 'jaw board', in which all mandibles are physically laid out in order from least to most amount of wear is used for reference (Aitken 1975). The reference mandibles

belonged to deer of known ages or aged using cementum annulation analysis (Aitken 1975). Using these as comparison, the remaining mandibles are assigned approximate ages according to tooth wear, then checked for accuracy using cementum annulation age estimation (Aitken 1975). The purpose of this study is to test the accuracy of relative age estimation based on tooth wear (Aitken 1975). This method is reportedly fairly accurate, 90–95% within a year of the cementum age (Aitken 1975, 24). While the author proves the validity of this technique, what became of the reference mandibles (the 'jaw board') is unclear (Aitken 1975). The author provides descriptions of tooth wear for one year age intervals up to eight years accompanied by oblique-angle sketches for some ages. Nevertheless, these descriptions are brief and suffer from vague and relative language (Aitken 1975).

One way to mitigate reproducibility issues and viewer subjectivity in reference material is with black and white, easily replicable wear pattern illustrations. Grant (1982) developed a method using tooth wear patterns for sheep/goats, cattle, and pigs which became one of the most frequently employed ageing techniques for domestic animals. This process is similar to that described above. Mandibular occlusal wear patterns representing a spectrum of wear stages from very young to very old are selected to be illustrated and ordered from minimum to maximum wear, including the eruption of deciduous dentition (see Figure 4 for example) (Grant 1982). Ideally, the mandibles have known age data, or otherwise accurately aged, animals (Grant 1982). However, because Grant (1982) did not have access to known-age data while developing this method, the age classes are relative only. Each tooth (dp_4, P_4, M_1, M_2, and M_3) is compared to the wear stages illustration and assigned an alphabetical value referred to as the tooth wear stage (TWS) (Grant 1982). The TWS corresponds to a numerical value found in a table (Grant 1982). The mandible wear stage (MWS) is the sum of the TWS values from M_1, M_2, and M_3 and is the value used to assess relative ages (Grant 1982). Although each tooth is assessed separately, this system does not handle fragmented mandibles well (Grant 1982). All three molars are needed to calculate MWS and if a tooth is absent Grant (1982, 96) proposes guessing the TWS of the missing tooth based on those present.

Efforts have been taken to adapt Grant's (1982) diagrams for other species. Bowen and colleagues (2016) follow a similar methodology to estimate ages of fallow deer using the same style of tooth wear pattern illustration while also incorporating tooth eruption sequences. Since their sample consists of fallow deer mandibles from a full range of known ages (0–16 years) they are able to convert their wear stages into estimated age ranges (Bowen et al. 2016). The degree of accuracy this method produces is adequate for archaeological purposes, achieving better accuracy with all three molars than for single tooth (79–96% in correct age category or 100% within one age category) rather than for single teeth (79–96% or 93%, respectively) (Bowen et al. 2016, 1095).

Similarly, van den Berg and colleagues (2021) adapt this approach for Svalbard reindeer. Using known-age individuals, they create two schemes: the 'absolute scheme', and the 'relative scheme' (van den Berg, Loonen, and Çakırlar 2021). The 'absolute scheme' is only for Svalbard reindeer mandibles (van den Berg, Loonen, and Çakırlar 2021). The 'relative scheme' could be applied to any reindeer or caribou population but requires the user to calibrate this scheme themselves using either known age or accurately ageing reindeer mandibles from the relevant region (van den Berg, Loonen, and Çakırlar 2021). There are also separate tooth wear illustrations for each scheme demonstrating the variation of wear between Svalbard reindeer and other *Rangifer* populations (van den Berg, Loonen, and

Çakırlar 2021, 4–6). Unfortunately, this method leaves the potential user outside the Svalbard region with three options: apply the 'absolute scheme' with the assumption that the accuracy will be close enough to be meaningful, apply the 'relative scheme' without assigning ages in their analysis, or calibrate the 'relative scheme' themselves (van den Berg, Loonen, and Çakırlar 2021). Not only would time be needed to calibrate this scheme, but if known-age specimens are unavailable, destructive and time-consuming cementum annulation may be required (van den Berg, Loonen, and Çakırlar 2021) and is not as reliable as true known-ages (Miller 1974).

Without a collection of appropriate known-age reference animals, approximating the rate of wear and estimating age is challenging. Salvagno and colleagues (2021) apply Grant's (1982) method for pigs (outliers in this article as they are not ruminants) to assess the rate of wear in archaeological populations. Assuming that tooth eruption is relatively regular and that molars erupt in the order of M_1, M_2, and then M_3, this approach considers the difference in wear in pairs (Salvagno et al. 2021). The difference between the M_1 and M_2, and between the M_2 and M_3, represents how much wear these teeth experience in the amount of time between each eruption and first comes into wear (Salvagno et al. 2021). The authors use this method to test the diets of ancient pigs at various times in the past, but such an approach may also be effective as an index of wear to calibrate ruminant ageing schemes between populations (Salvagno et al. 2021).

Payne's (1973; 1987) system for ageing sheep and goats is like Grant's (1982) except that this method further develops this strategy to evaluate and simplify the characteristics of the occlusal wear pattern. This method has also been frequently applied, often in comparison with Grant's (Bowen et al. 2016; Greenfield and Arnold 2008; Hillson 2005; Lubinski 2001; Twiss 2008; Reitz and Wing 2008) and has been adapted to other species including cattle (*Bos taurus*) (Halstead 1985), pigs, and wild boar (Bull and Payne 1982). Occlusal wear patterns are represented with rectangular schematic depictions that record worn and unworn enamel cusps, shapes and connections between exposed dentine, and the presence and size of infundibula (Payne 1973, 288). The schematic patterns are then translated to one of nine stages (from A-I) which provides an age range for each (Payne 1973, 288). Over a decade later, Payne (1987) improved this approach by assigning alphanumeric codes to each possible wear pattern to facilitate description in writing and be simpler for publishing.

Attempts have been made to reconcile the illustrative (Grant 1982) and schematic (Payne 1973; 1987) ageing schemes so that ages estimated using one method for a zooarchaeological assemblage can be meaningfully compared with others (Greenfield and Arnold 2008; Halstead's 1985; Hambleton 1998; Payne 1987). Payne (1987, Table 1) correlates the later coding scheme to Grant's (1982) MWS and TWS so that datasets could be translated from one to the other. Hambleton (1998) also converts between Grant's wear classes and both Payne's and Halstead's (1985) age stages. By applying the schematic method directly to Grant's illustrations, Hambleton (1998) converts them to Payne's age classes. While the conversion system developed by Payne (1987) includes a version for each tooth type so that every tooth would be converted individually, Hambleton's (1998) conversion is less flexible, looking at a whole mandible at a time. While the accuracy of each conversion has not been compared, converting the age classes of individual teeth and then assessing the MWS having better results seems likely. Following Hambleton (1998), Greenfield and Arnold (2008) suggest revisions to this conversion based on their own study of domestic sheep and goats from Manitoba. However, this study has limitations. Most of their sample size is

less than 18 months old and their revisions include only age classes when tooth eruption sequences are still more valuable than tooth wear patterns. They recommend that Grant's illustration method be used because only a one-way conversion from Grant's to Payne's methods is possible since this method had a greater number of MWSs, although neither Hambleton (1998) nor Payne (1987) mention such a restriction.

The popularity of the Visual Wear Pattern Method suggests that this approach is relatively easy to use while providing meaningful results. This method is straightforward to adapt to new ruminant species (Bowen et al. 2016; van den Berg, Loonen, and Çakırlar 2021; Lubinski 2001). Although Visual Wear Pattern Methods work for loose teeth or incomplete mandibles, the accuracy is severely reduced (Twiss 2008, 349). Twiss (2008, 346) abandons both Grant's (1982) and Payne's (1973) methods because the sheep and goat remains from Çatalhöyük are too fragmented and do not produce meaningful demographic profiles. Due to a lack of instruction or morphological description in Grant-style illustrations important details in the tooth wear pattern may be overlooked or misinterpreted (Hambleton 1998, 114

Wear Trait Scoring Method

Instead of visually or schematically analyzing wear patterns, another approach is to observe and count scores of the presence or absence of predetermined traits caused by tooth wear. Brown and Chapman (1990; 1991) were first to develop a mandibular wear scoring system for fallow deer followed by red deer. Each of the variations below seek to minimize subjectivity and observer error by allowing for only two options – either a trait is present, scoring a value, or absent, with a value of zero. They also intend to improve the accuracy of age estimation by increasing the resolution of wear stages, especially for older animals

Payne's (1987) revised method includes reference codes that could arguably be considered to evaluate present or absent traits, especially connections between dentine shapes and loss of infundibula, however, the result is evaluated as wear stages. Brown and Chapman (1991; 1990) take this further by using similar criteria for evaluating wear and adding a value for each occurrence in their methods for fallow deer and red deer. Observable traits are identified for all molars including enamel wear, dentine wear, ovals or 'eyes' that appear within the dentine, links between dentine, loss of infundibula, and dark staining of dentine (see Figure 5) (Brown and Chapman 1990; 1991). Those traits are scored between 0–2 and the total score for that tooth is summed (Brown and Chapman 1990; 1991). Premolars can also be scored, but the authors find them unreliable and, thus, are excluded (Brown and Chapman 1990; 1991). The authors include known-age

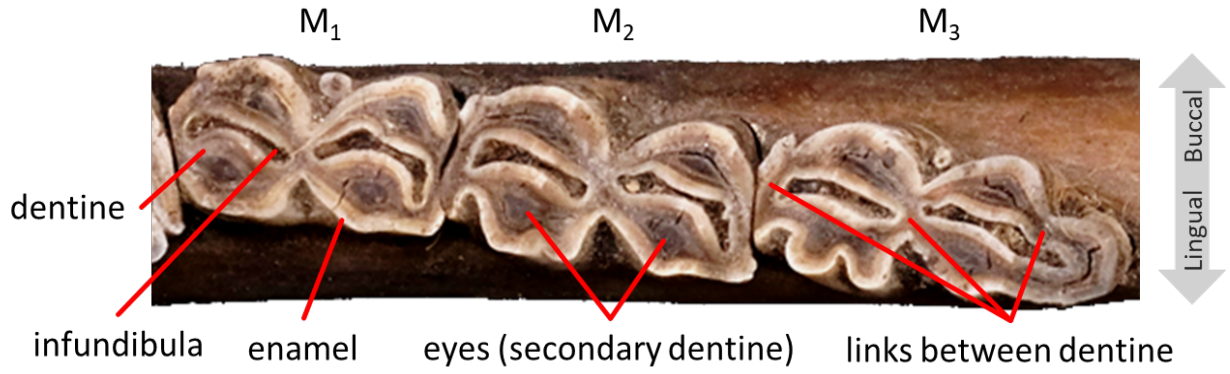

FIGURE 5–*Occlusal view of reindeer mandibular molars showing locations of tooth wear traits used for scoring estimating age (not exhaustive) (Created by author)*

animals to create a table where the estimated age class is determined using the total score for the mandible (Brown and Chapman 1990; 1991). A similar table exists for single molars, but singular teeth are considered less precise (Brown and Chapman 1990, 672). The systems for both species suffer from a lack of older individuals, likely contributing to the overlap in score values between older age classes (Brown and Chapman 1990; 1991).

Since published, multiple researchers have made efforts to improve upon this approach drawing directly from Brown and Chapman's (1990; 1991) work. For red deer, Dudley Furniss-Roe (2008) follows a similar workflow but generates new criteria using statistical analysis to weight the scores associated with each one. The full method includes 16–17 initial scoring elements for each molar and are applied to a known-age collection of red deer to statistically derive a weight for each scoring element between zero and three. After removing those with a score of zero, only eight traits remain, speeding up the process (Dudley Furniss-Roe 2008, 82–84). This is a relative scheme in which the final summed score could be calibrated for any population of red deer (Dudley Furniss-Roe 2008).

Other simplified versions have been developed. Clearly, the Wear Trait Scoring Method needed to be made more efficient and user-friendly (Lubinski 2001; Pérez-Barbería et al. 2014). Pérez-Barbería et al. (2014) simplify both Brown and Chapman (1990; 1991) and Dudley Furnace-Roe (2008) methods for red deer by seeking to eliminate redundancy and reduce the bias of traits while maintaining accuracy. The 'Simplified Brown and Chapman' and 'Simplified Dudley' schemes are both created by removing approximately 70% of the traits calculated to be statistically redundant. They also develop models that account for differing rates of wear between females and males. Likewise, Lubinski (2001) carries out a comparison of methods including counting exposed infundibula and a modified version drawing from Brown and Chapman (1990). This study looks at 3–4 traits of occlusal wear with reference to a schematic diagram and scoring each tooth (including molars and adult or deciduous premolars) in the mandible. Wear scores are calibrated using known-age (and established-age) pronghorn mandibles so that the score can be referenced to age classes (Lubinski 2001, 226). Pérez-Barbería et al. (2014) finds that their 'Simplified Dudley' method is the more accurate of the two. According to Lubinski (2001, 223), the tooth wear scoring system performs better than Payne's (1973) for younger individuals because ridges and facets are counted independently. Lubinski (2001, 226) dismisses using counts of exposed infundibula per mandible as an ageing technique finding this method too inaccurate for archaeological purposes.

Høye (2006) takes a somewhat different approach for roe deer, also drawing from Brown and Chapman (1990; 1991), but instead a probability score table is used to estimate age. With a sample of known-age roe deer, 18 occlusal wear characteristics are chosen and the probability of each occurring within an age category determines the most probable age of an individual (Høye 2006). All permanent molars and premolars are required (Høye 2006, 212–14). The accuracy of this study is mixed – accuracy is sufficient for roe deer younger than four years old but drops off in older ones (Høye 2006, 212–14).

Wear Trait Scoring Methods are found challenging to execute (Pérez-Barbería et al. 2014). If presented in a user-friendly fashion, these methods can be understood and applied by other researchers. However, Pérez-Barbería and colleagues (2014) needed to first clarify details and fix ambiguities with the original authors (Brown and Chapman 1991; Dudley Furniss-Roe 2008) and published clarified versions of each as appendices in their publication. Although the Wear Trait Scoring Method has been claimed to be more objective

than Visual Wear Pattern Methods (Lubinski 2001, 228), I do not wholly agree. Subjectivity certainly arises for 'close-calls', for example, a barely-there connection between shapes of dentine in which a characteristic must either be counted or not counted with no half measures. This score could easily be affected by the preference of the researcher and whether they are eager to count the trait as present or to be more conservative in their scoring.

As with Crown Height, Wear Trait Scoring Methods are quantitative and work well with statistical analyses, improving the accuracy of the age estimation. This approach also allows for slight variance in wear patterns as wear events may not occur in a regular order (Pérez-Barbería et al. 2014). Tooth wear traits do not correspond as well with tooth eruption sequences as other methods do (Brown and Chapman 1990). None include scores for tooth eruption, which is more accurate for ageing younger animals. A separate step of analysis would be required for younger-age mandibles. Additionally, these schemes are significantly more time consuming than the above-mentioned tooth wear ageing methods with more features to observe and more recording needed.

	Source	Species	Sample Size	Sample Age Data	Geography/Population	Age Range (years)
Crown Height	Bowen et al. (2016)	fallow deer (*Dama dama*)	156	known age	France (n=10), England (n=8), Ireland (n=138) (modern and historical)	0–16
	Klein and Cruz-Uribe (1983)	eland (*Taurotragus oryx*) and Cape buffalo (*Syncerus caffer*)	80 (eland) + 36 (Cape buffalo)	unknown age	South Africa (archaeological)	–
	Lowe (1967)	red deer (*Cervus elaphus*)	33	known age	Scotland (modern)	0–8
	Lubinski (2001)	pronghorn (*Antilocapra americana*)	59	known age (55) and known date of mortality (228)	Montana (modern)	0–>9
	Morrison and Whitridge (1997)	caribou (*Rangifer tarandus groenlandicus*)	74	cementum annuli	Qamanirjuaq herd, Canada (modern)	3–15
	Pasda	reindeer (*Rangifer tarandus groenlandicus*)	63	cementum annuli	Greenland (modern)	0–14
	Pike-Tay et al (2001)	caribou (*Rangifer tarandus groenlandicus*)	999	cementum annuli	Qamanirjuaq herd, Canada (modern)	0–16
	Steele and Weaver (2012)	elk (*Cervus elaphus*)	226	known age	Montana (modern)	0.5–21.5
	Twiss (2008)	sheep (*Ovis aries*)/goats (*Capra hircus*)	267	unknown age	Turkey (archaeological)	0–10
Visual Wear	Aitken (1975)	roe deer (*Capreolus capreolus*)	110	6 known age, 104 cementum annuli	Norfolk, England (modern)	2–7
	Bowen et al. (2016)	fallow deer (*Dama dama*)	156	known age	France (n=10), England (n=8), Ireland (n=138) (modern)	0–16

	Source	Species	Sample Size	Sample Age Data	Geography/Population	Age Range (years)
ctd.	Grant (1982)	sheep (*Ovis aries*)/goats (*Capra hircus*)	1301	unknown age	England (archaeological)	–
	Greenfield and Arnold (2008)	sheep (*Ovis aries*)/goats (*Capra hircus*)	41	known age	Manitoba, Canada (modern)	0-4.5yrs
	Halstead (1985)	sheep (*Ovis aries*), cattle (*Bos taurus*)	64 sheep, 20 cow	unknown age	England (archaeological)	–
	Hambleton (1998)	sheep (*Ovis aries*), cattle (*Bos taurus*), pig (*Sus scrofa*)	164 sheep, 120 cattle, 128 pig	unknown age	England (archaeological)	–
	Lubinski (2001)	pronghorn (*Antilocapra americana*)	284	known age (55) and known date of mortality (228)	Wyoming, Colorado, Montana (modern)	0 –>9
	Miller (1972)	caribou (*Rangifer tarandus groenlandicus*)	356	cementum annuli	Qamanirjuaq herd, Canada (modern)	0–3
	Miller (1974)	caribou (*Rangifer tarandus groenlandicus*)	999	cementum annuli	Qamanirjuaq herd, Canada (modern)	0–16
	Mutze (2021)	sheep (*Ovis aries*)	1701	known age	UK and Germany (modern)	0–14
	Payne (1973; 1987)	sheep (*Ovis aries*)/goats (*Capra hircus*)	147	unknown age	Turkey (archaeological)	0–10
	Twiss (2008)	sheep (*Ovis aries*)/goats (*Capra hircus*)	47	unknown age	Turkey (archaeological)	0–10
	van den Berg et al. (2021)	Svalbard reindeer (*Rangifer tarandus platyrhynchus*)	292	cementum annuli	Norway (modern)	0–17
Wear Trait Scoring	Brown and Chapman (1990)	fallow deer (*Dama dama*)	53	known age	England (modern)	0–8
	Brown and Chapman (1991)	red deer (*Cervus elaphus*)	111	known age	England (modern)	0–11.5
	Dudley Furniss-Roe (2008)	red deer (*Cervus elaphus*)	118	known age	Scotland (modern)	0–20
	Høye (2006)	roe deer (*Cervus elaphus*)	471	known age	Denmark (modern)	0–14
	Lubinski (2001)	pronghorn (*Antilocapra americana*)	59	known age (45) and known date of mortality (14)	Montana (modern)	0 – >9
	Pérez-Barbería et al. (2014)	red deer (*Cervus elaphus*)	694	known age	Scotland (modern)	0–16

TABLE 1–*Sample sizes used in developing or improving age estimation techniques as outlined in this review paper (Created by author)*

DISCUSSION

Age estimation methods are applicable between populations, including from different time periods, where no significant difference in tooth morphology and diet can be demonstrated (Spinage 1973). These methods largely rely on modern sample populations with known-ages (or accurately aged) to be calibrated and provide estimations in years (see Table 1). In the other direction, tooth wear data from archaeological populations are not useful for estimating the ages of modern animals because information for individual animal ages or life histories are not known. For example, reindeer in Greenland and North American caribou living in tundra environments (Pasda 2009) are more cross-comparable than Svalbard reindeer (van den Berg, Loonen, and Çakırlar 2021). This subspecies has been genetically isolated in a high arctic island environment for millennia and has a different mandibular morphology and diet (Reimers, Eftestøl, and Colman 2021; van den Berg, Loonen, and Çakırlar 2021). Similarly, Pérez-Barbería, Carranza, and Sánchez-Prieto (2015) demonstrate that red deer in Scotland have significantly slower dental attrition than red deer in Southern Spain, which is likely caused by the drier, courser diet available to the Spanish population. Although not the aim of this study, the authors provide different crown height regression equations for each sex of each population that could be applied in relevant zooarchaeological research contexts (Pérez-Barbería, Carranza, and Sánchez-Prieto 2015).

In contrast, ageing methods for domestic animals such as sheep, goats, cattle and pigs, namely Grant's (1982) and Payne's (1973; 1987) methods, have been applied to assemblages from varying geographical and time period contexts with success (for examples: Brunson, He, and Dai 2016; Crabtree 1996; Greenfield et al. 1988; Greenfield and Arnold 2008; 2015; Groot 2016; Halstead 1985; Hambleton 1998; Janzen, Balasse, and Ambrose 2020; Landon 1996; Munson 2000; Pilaar Birch et al. 2019; Rabinovich and Hovers 2004; Stiner 1990; Twiss 2008). Although a geographical and temporal survey of cross-applicability of tooth wear ageing methods is beyond the current scope, this paper has demonstrated that a researcher using a method developed from one population for another population must have reasonable expectations for the accuracy and precision they will achieve.

An understanding of the accuracy inherent in each method is important to know what expectations are reasonable. Tooth wear is not accurate enough to predict seasonality (Spiess 1979, 70–71). In contrast, tooth eruption sequences may be used to estimate age with accuracy from several months to a year, depending which tooth is analyzed (Hillson 2005). Tooth eruption sequences must be well studied for a specific species. When birth times are seasonal and occur within a short time frame, the age of an animal can help estimate the season of death as well (Bergerud 1970; Bowen et al. 2016; Lubinski 2001; Miller 1972; Spiess 1979, 70). One of the greatest determining factors for accuracy and usefulness is the presence and quality of a known-age reference sample to draw from (Grant 1982, 105; Dudley Furniss-Roe 2008; Brown and Chapman 1990, 678; Lubinski 2001, 219). A lack of older animals in the sample will reduce the sensitivity of the model for those ages.

A similar level of accuracy is achieved for the two methods that rely on occlusal tooth surface observations, the Visual Wear Pattern and Wear Trait Scoring Methods. For younger adult individuals, these methods generally yield satisfactory accuracy within a year or two of known age. For example, Aitken's (1975, 24) 'jaw board' was fairly accurate; 90–95% were aged correctly within a year of the cementum age. Lubinski (2001, 223) finds that for younger stages or wear, their Wear Trait Scoring Method for pronghorn antelope

derived from Brown and Chapman (1990) performs better than the Visual Wear Pattern Method following Payne (1987). In contrast, Crown Height Methods generally do not yield results as accurately. Twiss (2008, 344) finds that LCHM is not meaningful over four years old, and Klein and Cruz-Uribe (1983, 76) realizes that QCHM is inadequate by both overestimating and underestimating ages; however, the positive and negative inaccuracy would balance out in a larger population. Additionally, Crown Height and Wear Trait Scoring Methods are quantitative and work well with statistical analyses, improving the accuracy of the age estimation (see Twiss 2008; Pérez-Barbería et al. 2014). This approach also allows for slight variance in wear patterns as wear events may not occur in a regular order (Brown and Chapman 1990, 678–79).

Each of these approaches involves distinct procedures that differ in user-friendliness and in efficiency. Crown Height and Visual Wear Pattern Methods would take significantly less time to complete than Wear Trait Scoring Methods because there are so many more features to examine per specimen. Lubinski (2001, 223) refers to Brown and Chapman (1990) as being more 'cumbersome'. Indeed, this issue is the purpose of Pérez-Barbería and associates' (2014) article that seeks to eliminate redundant traits and speed up the process. The traits in Wear Trait Scoring Methods do not coordinate as well with tooth eruption sequences as other methods since none include scores for tooth eruption. An additional step of analysis would be required for younger-age mandibles. In a general sense, this approach is more time consuming with more features to observe and more recording required.

An important factor in assessing usefulness also depends on the species and whether someone has created a calibrated method using known or precisely aged mandible collections for that species or population (Hillson 2005, 212). Some species, including reindeer and caribou, vary substantially in tooth eruption times and rate of wear between populations across the Circumpolar North (Miller 1974, 16; see also Bergerud 1970; Pasda 2009, 32; Spiess 1979, 76). The process of calibrating an existing relative ageing scheme would undoubtedly be difficult and require access to an adequately relevant sample of mandibles. This is true for any uncalibrated tooth wear ageing method.

Animal remains from archaeological sites may be recovered in varying degrees of fragmentation. Therefore, which tooth wear age estimation method will be most suitable is important to consider. For highly fragmented assemblages with loose (but intact) teeth, the Crown Height Method may be a strong choice (Klein and Cruz-Uribe 1983; Lyman 2017; Twiss 2008). The other tooth wear methods lose much of their accuracy when only one tooth is considered (Twiss 2008). However, if mandibles are fully or partially complete and teeth are socketed, crown height often cannot be measured if the cementoenamel junction is covered by the mandible (Twiss 2008, 343). Additionally, if preservation is too poor and cusps are damaged, this prevents measuring crown height as well (Twiss 2008, 343). Both other occlusal wear approaches have the ability to contend with individual teeth or incomplete dentition, the accuracy of the estimated age might just be less robust (Twiss 2008, 343).

CONCLUSION

Tooth wear age estimation is an effective method of inferring the age-at-death of animals from archaeological sites. Methods for ageing Cervidae and Caprinae have been considered in this review. This approach to age estimation is substantially more efficient, easier to learn, provides faster results, and does not require destruction of specimens as is the case with cementum increment analysis. Despite these positives this approach is an ageing method that is not without sources of inaccuracy. Tooth wear ageing methods can be employed in zooarchaeology to estimate ages

of adult animals and cover all life stages when applied in conjunction with tooth eruption sequences. These estimated ages can be compiled to reconstruct demographic profiles of the population of animals recovered from an archaeological site. Age-based demographic profiles provide valuable insight into how people were interacting with animal populations, such as selection and strategy during hunting and livestock management (Klein and Cruz-Uribe 1983; Gifford-Gonzalez 2018; Reitz and Wing 2008; Russell 2012).

Dental attrition is ultimately the result of the amount of food and particulates chewed over a lifetime. The rate of attrition if affected by diet, behaviour, age, sex, population, and any dental anomalies or traumas. These variables need to be understood to recognize the limitations inherent in tooth wear ageing. Despite these sources of variation, the rate of wear must be assumed to be predictable within an individual's lifetime, between individuals within a population, and between populations that are used together in analysis. These assumptions are necessary for the three overarching approaches outlined in this paper, the Crown Height Method, the Visual Wear Pattern Method, and the Wear Trait Scoring Method.

Different research contexts call for different tooth wear ageing approaches to provide meaningful results. This paper shows that the various ways of quantifying tooth wear for cervids and caprines differ in accuracy, efficiency, and user-friendliness. Crown Height provides a statistically-friendly method that is well suited for loose, yet intact teeth. Visual Wear Patterns are efficient, intuitive, and can be carried out remotely or in the field; however, many of the specific approaches that have been developed are better suited to complete mandibles. Wear Trait Scoring Methods provide thorough results but need complete mandibles (at least all three molars) and are relatively time consuming. This article demonstrates that there is no one approach to tooth wear age estimation for all zooarchaeological research projects.

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