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KNOWLEDGE ACQUISITION ON AFRICA THROUGH AFRICAN AND GENDER STUDIES CURRICULUM: BLACK/AFRICAN TERTIARY STUDENTS' PERCEPTIONS AND OUTCOMES IN A DEVELOPING CONTEXT (GHANA)

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Abstract

This paper seeks to improve the discourse on African Studies by taking a retrospection of an introductory course at a public tertiary institution in Ghana (West Africa). African Studies and Gender Studies are interdisciplinary academic fields that promote Africa-focused knowledge and gender perspectives. Students gain knowledge of African reality, become conscious of gender and Africa-related stereotypes, and are equipped to confront these preconceptions. This paper aims to investigate the course's outcomes and understand how students perceive African and Gender Studies curriculum. A qualitative research approach was adopted to gather data from 50 Black/African students at a public university who took a one-semester African Studies course during the 2022–2023 academic year. The data were subjected to thematic analysis. The study revealed that students were able to relate the course to themselves from Afrocentric and gender viewpoints which will enable them to contribute the knowledge and skills that they learned to the development agenda's goal towards a sustainable Africa. Moreover, it made it easier for them to connect with their peers since it taught them to treat everyone fairly and reject sexism. Students also benefitted from the course delivery methods such as group activities, multimedia, and art performances that provided room for greater idea exchange, engagement, discussion, and conceptual clarity. They ultimately provide students with the opportunity to gain practical knowledge about the African continent and the African people, and hence, there is a need for pedagogical modification that emphasizes practical components.

Keywords: Africa, Gender, Black/African, Curriculum

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Introduction

The teaching of African Studies has been a requisite part of public higher education in Ghana since the political independence era and continues to play a major role in the training of public university and public college graduates in the country in the 21st century. This curriculum initiative was spearheaded by the first Prime Minister and President of the Republic of Ghana, Osagyefo ("Redeemer" in the Akan language) Dr. Kwame Nkrumah, as a means of achieving national self-determination in Ghana and to contribute to the realisation of the Pan-African "educational visions" (Abraham, 2022, p. 20) that were spreading across the African continent and throughout the African world community during the 1960s (Frehiwot et al., 2022). It was Nkrumah's vision that an African-centred, interdisciplinary higher education programme in African Studies would provide students with the opportunity to gain practical knowledge about the African continent and the African people. Such a programme would be an alternative to the colonialist, Eurasian vision of African Studies. In his book titled *I Speak of Freedom: A Statement of African Ideology* (1961), Nkrumah discussed the importance of African Studies in the context of African liberation and the decolonisation struggle. He argued that the African people must understand their history, culture, and heritage in order to assert their independence and sovereignty effectively.

In a visionary speech titled "The African Genius" that was delivered "on the occasion of the opening of the Institute of African Studies (IAS) at the University of Ghana, Legon, 25th October, 1963", Nkrumah placed emphasis on the critical need to "study the history, culture and institutions, languages and arts of Ghana and of Africa in new *African-centred* [emphases added] ways" (Manuh and Sutherland-Addy, 2013, p. vii). Indeed, he was clear in his envisioning of African Studies in Ghanaian universities as a means of teaching and learning more about Africa and about the global African Diaspora – vis-à-vis the study of the African continent as well as the inclusion of "a study of the origins and culture of peoples of African descent in the Americas and the Caribbean". Contemporary scholars of African Studies also include African-descended people in Eurasia and the Pacific world as a part of the global African Diaspora (Rashidi, 2017; Manuh and Sutherland-Addy, 2013, p. vii; Palmer, 2000).

The audience (and later readers) of Nkrumah's speech were prompted to ponder two of the more pressing questions that he posed to African intellectuals early on in "The African Genius":

What sort of Institute of African Studies [and here we can include "Introduction to African Studies"] does Ghana want and need to have? In what way can Ghana make its own specific contribution to the advancement of knowledge about the peoples and cultures of Africa through past history and through contemporary problems?

For what kind of service are we preparing students of this Institute and of our [u]niversities? Are we sure that we have established here the best possible relationship between teachers and students? To what extent are our universities identified with the aspirations of Ghana and Africa? (Manuh and Sutherland-Addy, 2013, p. vi)

These kinds of self-reflexive questions point to the fact that teaching and learning about Africa can have a significant impact on the social and cultural development of Black/African students in Africa and in the global African Diaspora (Traoré, 2007). In addition to providing a counternarrative to Eurasian historical and contemporary biases about Africa and the African people, African-centred approaches to African Studies can serve as catalysts for the

sustainable development of Africa, not only via a rejection of anti-Black/African ideology, but as a source of vital indigenous information that can contribute to finding solutions to the contemporary African crisis of development (Asante, 2021; Frindéthié, 2010; Mkabela, 2005). Indeed, in his book titled *Consciencism: Philosophy and Ideology for De-colonization* (1964/1970), Nkrumah delved into philosophical and ideological aspects of African Studies, particularly in the context of decolonisation. He emphasised the need for African intellectuals to develop a coherent African philosophy rooted in their own history and culture.

Understanding Africa and the African people both inside and outside the continent overlaps with the emphases that the African Studies and Gender Studies components of an "Introduction to African Studies" course recently offered at a new public university in a developing context placed on the concepts of interdisciplinarity, discipline, Afrotransdisciplinarity, Africologists, Africology, the Africological paradigm, Afrocentricity, gender, sex, biology, culture, patriarchal ideology, gender roles, stereotypes and prejudice, gender division of labour, gender socialisation, as well as gender equity and equality. Indeed, these are concepts that leading African Studies and Gender Studies scholars utilise in their teaching and research. Thus, the concepts were re-emphasised throughout the course in order to set the stage for ongoing lectures and discussions. Afrocentricity, "a mode of thought and action in which the centrality of African interests, values, and perspectives predominate", in particular has played a critical role in the transformation of the negative and normative view of Africa as a place without a history until the arrival and subsequent invasion of Eurasian influences (Flannery, 2022; Asante, 2021; Kambon, 2017; Zulu, 2007; Mazama, 2003; Asante, 2003, p. 2).

During the first semester of the 2023 calendar year, an introductory course in African Studies was offered at a public university in Ghana (West Africa) by a team of African Studies and Gender Studies specialists who employed a multidisciplinary range of pedagogical approaches to help students gain a more comprehensive understanding of Africa. The introductory course encouraged students to challenge existing global knowledge in order to develop appropriate methodologies and theories for examining Africa through multidisciplinary approaches.

In the spirit of indigeneity, the African Studies content of the course was principally guided by an African-centred textbook that was specifically designed for undergraduate students. In the "Introduction" to *Africa in Contemporary Perspective: A Textbook for Undergraduate Students*, co-editors Takyiwaa Manuh and Esi Sutherland-Addy placed emphasis on the foundational importance of "African-centred perspectives in all aspects of the production and dissemination of knowledge" in the required "introductory, multidisciplinary course on Africa" in all public universities and public colleges in Ghana (Manuh and Sutherland-Addy, 2013, p. 1). In addition to lectures and tutorials covering "Gender Issues in Africa" and "Gender Equality and Empowering Women and Girls", content from Molefi Kete Asante's African-centred *History of Africa: The Quest for Eternal Harmony* (2019), particularly content that focused on the origins of humanity in Africa and classical African civilisations, was also central to the African Studies component of the course. Additional African-centred works by Cheikh Anta Diop (1985), Maulana Karenga (2010), and Manu Ampim (2003), for example, were put into conversation with content from the first episode of Henry Louis Gates, Jr.'s *Africa's Great Civilizations* (2017) documentary film series, particularly the episode's focus on

(a.) the origins of the first modern human beings in Africa before any other continent had modern human beings as well as (b.) Nile Valley and other classical African civilisations. Guided by the textbook that was edited by Manuh and Sutherland-Addy, the lectures and tutorials for the course also explored the following selected topics from the textbook's themes via African-centred lenses: "Cultural, Social & Political Institutions"; "Economy, Livelihoods & Security"; "Health, Environment, Science & Technology"; and "Artistic Expression and Performance in Africa" (Manuh and Sutherland-Addy, 2013, pp. iii-iv). Multimedia, such as the documentary film *Healers of Ghana* (Dodds, 1993) (originally titled *Bono Medicines*, 1982), were also integrated into the coverage of the aforementioned topics.

As part of the curriculum, the instructors for the course decided to adopt student-centred learning, where students were given more opportunities to play an active role by taking part in small projects, debates, role plays, etc. As part of this, the instructors took up the initiative of celebrating Africa Day. During the Africa Day celebration, students showcased the knowledge that they gained from the course to the university community via ethnic/national dress and/or performance (music, dance, drama, written and oral literature, etc.). The purpose of this class activity was to give students an opportunity to practicalise information from African Studies and Gender Studies, as well as to contribute to the internationalisation of the university.

It was a group activity where each group chose a selected topic in African Studies and Gender Studies and showcased it in any format within 10 minutes. Students brought the properties necessary for their performance. Students' presentations on selected topical issues in African Studies and Gender Studies were assessed by a team of judges from the university teaching staff. After the panel of judges assessed their performance, scores were given. The criteria for assessment were based on the following: appearance, content, delivery, organization and time, and relevant prop usage. These scores were added to the internal marks that students received in the course.

Significance of the Study

Contemporary Africa is a dynamic and multicultural continent growing its economies at a very fast rate; hence, there is a need for the growing class of Black/African intellectuals to take the lead in supporting national development. This view is not different from the "educational visions" that were articulated by Pan-African leaders such as Kwame Nkrumah and Mwalimu ("Teacher" in the Swahili language) Dr. Julius Nyerere (first Prime Minister of Tanganyika and the first President of the United Republic of Tanzania), for whom, as stated by G. Y. Abraham, education is meant for "creating a good relationship with the society and putting in focus the development of society" (Abraham, 2022, pp. 20, 22). In view of this, there is a need for African students to take courses relating to their roots and developments over the years. In an African country such as Ghana, there are African Studies courses in tertiary institutions where students at the undergraduate level take an introductory African Studies course at some stage in their studies. The African Studies course is part of an interdisciplinary academic field that promotes Africa-focused knowledge for students. It is a university-required course for all students irrespective of their disciplines. The course gives students the opportunity to make sense of realities from the perspectives of all information gained from African cultures in particular, hence building a solid foundation for students to relate to issues from an African viewpoint. Again, beyond the individual's personal experiences, the course tackles disparity issues in the African setting, opening space for Gender Studies and other identity-based concepts

debunking myths, male power, and ethnocentrism.

The "Introduction to African Studies" course at the University of Environment and Sustainable Development (UESD) in Somanya, Eastern Region, Ghana, is taught in units by experts in two fields—African Studies and Gender Studies—and is offered to all second-year students at the university. The bases of its expected learning outcomes are to enable students to (1) articulate a fuller understanding about the historical development and social construction of African societies and civilisations and (2) describe and explain the relationship and impact of gender on development in Africa.

Students who take the course have diverse cultural backgrounds and experiences. This may be one of the reasons for the different perceptions about the course. Ou (2017) agrees with this opinion; he observed, "It is not difficult to notice that, in our contact with the outside world, external objects are the same, whereas our responses towards and interpretations of them are different. This is because perception is culturally determined. Culture influences the way people perceive the world and events" (p. 21). *Longman Dictionary of Contemporary English* defined perception as "a) the way you think about something and your idea of what it is like; b) the way that you notice things with your senses of sight, hearing etc.; c) the natural ability to understand or notice things quickly" (Ou, 2017, p. 18).

Although most students admitted to UESD excelled in related courses such as social studies at the senior high school level prior to entering the university, it is a bit disturbing to note that some students do not give the African Studies course the needed attention, thus devoting less time to its study. Others feel reluctant to attend lectures and hence often turn up late. These and other factors are affecting the performance of some students in the course.

This study explores the learning outcomes and the perceptions of students who took the African Studies course at UESD in the 2022/2023 academic year. Given the "purposive integration of various disciplines applied to solve real-life problems" (Çalışıcı and Sümen, 2018, p. 871) via the incorporation of Gender Studies into the African Studies course, the findings of this study may help both African Studies and Gender Studies lecturers and other stakeholders to come up with better strategies which will benefit both tertiary students and public (and other) institutions of higher learning in Ghana, across the African continent, and beyond. These strategies may also help the contemporary African people to gain better understanding of the course and stimulate the interests of students who see the introductory African Studies course as a wide bridge to cross.

Literature Review

This study has adopted the theory of Afrocentricity. This theory, also known as Afrocentric theory, is an intellectual and political movement that evolved during the 1980s, initially among African American scholars and activists. Specifically, the term Afrocentricity was coined by Molefi Kete Asante (Asante, 2003). Earlier authors who contributed to the emergence of Afrocentricity were Cheikh Anta Diop, a Senegalese scientist who wrote about the cultural unity of Africa, the African nature of Kemetic (Ancient Egyptian) civilization and the "theft" of African civilization by Europeans, and Carter G. Woodson, an African American historian who emphasised the teaching of African history as a way of counteracting feelings of inferiority inculcated in Black people through centuries of subordination by White people.

This theory seeks to reclaim and reassert the cultural, historical, and philosophical heritage of Africa and the global African diaspora, challenging dominant Eurocentric perspectives and narratives. This approach

intersects with the primary reasons why Kwame Nkrumah proposed and implemented the learning of African history and culture in African universities:

1. Centring African experiences and perspectives
2. Challenging Eurocentrism and cultural imperialism
3. Reclaiming African history, culture, and identity
4. Promoting self-determination and empowerment
5. Fostering a sense of community and solidarity among people of African descent

In view of the above, Afrocentric theory has contributed significantly to the fields of African Studies, critical race theory, and decolonial thought channelled in the lessons of students at UESD.

Historical Context and Evolution of African and Gender Studies Curriculum

Origin and Growth of African Studies and Gender Studies

The genesis of African Studies and Gender Studies, particularly within the African knowledge production context, stems from two distinct but interconnected historical pathways. African Studies emerged mainly as a response to the Eurocentric representations of the African continent. As Nkrumah (2013) points out, post-independence African intellectuals sought to reclaim their narratives from the legacy of colonial misinterpretations.

Gender Studies, on the other hand, germinated from global feminist movements that questioned traditional gender roles and the oppression of women. In the African context, it can be argued that African women, facing double colonisation – being African and female – started to question their place in society, fostering the growth of gender-focused studies within the continent (Mikell, 1997).

Evolution of the Curriculum

The curricula for both African Studies and Gender Studies have been dynamic. With the rapid societal changes, new insights, and evolving research methodologies, educators recognised the need for more intersectional perspectives. Crenshaw (1989) introduced the concept of intersectionality to describe the interconnected nature of social categorisations such as race, class, and gender, leading to overlapping systems of discrimination or disadvantage. This perspective began to influence the African and Gender Studies curriculum, urging scholars to analyse how, for instance, the experiences of an African woman from a lower socioeconomic class differ from those of an affluent African male or a working-class African male.

Furthermore, the concepts of race and class have become central to studies in the postcolonial African context. Scholars recognised the interconnectedness of these facets in shaping experiences, especially as postcolonial Africa grappled with class disparities and the lingering impacts of racial hierarchies (Mama, 1995).

Challenging the Western-Centric Knowledge Production Approach

A significant shift in African Studies was the move away from the traditional Western-centric knowledge production approach. Historically, knowledge about Africa was primarily produced by Western scholars who brought with them inherent biases and often misunderstood or misrepresented African societies (Mudimbe, 1988). The postcolonial period marked a renaissance in African knowledge production. African scholars and intellectuals, equipped with a deeper understanding of their cultures and histories, began to challenge, deconstruct, and redefine the narratives about their continent.

The introduction of African-centred curricula in institutions of higher learning

played a pivotal role in this shift. By focusing on indigenous methodologies, languages, and frameworks, these curricula sought to build a body of knowledge rooted in African experiences and perspectives (Brock-Utne, 2002).

In the realm of Gender Studies, the Western-centric narratives often failed to capture the complex sociocultural dynamics of gender roles and relations in various African societies. Instead, there was a tendency to homogenise and essentialise the experiences of African women. Thus, African feminists and gender scholars embarked on a journey to redefine feminism and gender roles from an authentically African perspective (Oyěwùmí, 1997).

The development of the African and Gender Studies curriculum, particularly within the framework of African knowledge production, serves as a symbolic representation of the wider endeavour to regain and redefine African narratives. Through the integration of intersectional perspectives and the critical examination of Western-centric attitudes, these academic disciplines have flourished into well-established areas of study that comprehensively encompass the diverse and multifaceted nature of African experiences.

Black/African Students' Perceptions and Outcomes

Perceptions of African Studies and Gender Studies Curricula

For Black/African students, African Studies and Gender Studies curricula often hold symbolic importance. Studies indicate that these students perceive these subjects as platforms where their histories, experiences, and identities are centred and validated. Harper (2009) found that curricula focusing on African and diasporic experiences often provide a counternarrative to the predominant Eurocentric education system, allowing Black students to see themselves represented in academic discourse.

Similarly, Gender Studies can be particularly impactful for Black women, who often find themselves at the intersection of racial and gender discrimination. According to Collins (2000), Black feminist thought challenges the dominant paradigms of Gender Studies by foregrounding the experiences and challenges faced by Black women specifically.

Impact on Academic and Personal Outcomes

Engaging with African Studies and Gender Studies has demonstrable benefits on academic outcomes for Black/African students. Cokley (2003) suggests that these courses foster a sense of belonging and validation, leading to increased academic engagement and performance. Furthermore, these curricula may enhance students' critical thinking abilities as they challenge the traditional narratives that they have previously encountered.

On a personal level, these subjects can significantly impact identity formation and self-concept. By studying the histories, challenges, and triumphs of Black communities and individuals, students can connect their personal experiences to larger sociocultural and historical contexts, fostering a stronger sense of self and community.

Reported Experiences and Challenges

While many Black/African students find these curricula enriching, there are challenges. Some students report feeling tokenised or burdened to be the representative voices for all Black experiences in class discussions, leading to undue pressure and potential stereotype threat (Steele, 1997).

Another challenge is the curricula's comprehensiveness. When it comes to the

diasporic content of African Studies courses that focus on slavery, the academic focus on the "western diaspora", for example, has been criticised for ignoring the "eastern diaspora" wherein "our brothers and sisters … were enslaved in the eastern hemisphere of the Afrikan=Black Diaspora". This can make students from non-Western backgrounds feel excluded or undervalued (Kambon, Songsore, and Aketema, 2023, p. 23).

Influence on Understanding of Identity and Societal Roles

Engagement with African Studies and Gender Studies has profound implications for Black/African students' understanding of their identities and roles in society. By learning about historical figures, movements, and events centred around Black experiences, students are better equipped to contextualise their place in the world. This can also foster a sense of empowerment and agency, reinforcing the idea that Black individuals and communities have always been, and continue to be, active agents in shaping their destinies, resisting oppression, and contributing to global histories and societies (hooks, 1994).

African Studies and Gender Studies curricula are not just about diversifying educational content. For Black/African students, it is about seeing themselves reflected in what they learn, understanding their histories and potentials, and gaining tools to navigate a world that frequently marginalises their experiences.

Intersectionality and Gender in the African Studies Curriculum

Importance of Gender as a Core Aspect of the African Studies Curriculum

The inclusion of gender is not merely about adding women's voices or histories but rather entails a critical examination of how gender relations influence power dynamics, social structures, and historical narratives in Africa. Gender plays a pivotal role in understanding political, economic, social, and cultural processes in the continent (Oyěwùmí, 1997). Ignoring gender equates to neglecting a central component that shapes experiences, identities, and histories of African societies.

Integration of Gender Studies into African Studies

Historically, African Studies was dominated by narratives that marginalised or entirely excluded the roles and contributions of women and non-binary individuals. However, with the rise of feminist movements and Gender Studies globally, there has been a concerted effort to integrate gender perspectives into African Studies. The 1980s and 1990s saw a burgeoning of gender-focused research in Africa (Mama, 1996). As a result, this integration has:

(a) Highlighted the Roles of Women in History: From queens like Nefertiti of Kemet (Ancient Egypt) and Amina of Zazzau (contemporary Zaria) in Nigeria to modern-day activists, integrating gender has brought to light the pivotal roles women have played throughout African history.

(b) Introduced Diverse Methodologies: Gender Studies often uses qualitative and participatory methods, which have enriched the research processes in African Studies.

(c) Challenged Dominant Narratives: It has prompted a reevaluation of existing assumptions and stereotypes, especially those stemming from colonial legacies (Amadiume, 1987).

Benefits, Drawbacks, and Challenges of Integration

The integration of gender perspectives in African Studies has contributed to a more comprehensive and nuanced comprehension of African communities, histories, and cultures.

The empowerment of marginalised voices has been facilitated through gender-focused research, providing a forum for these individuals to articulate and shape their own histories and narratives.

The promotion of equality is facilitated by this integration, which presents a challenge to conventional patriarchal and sexist standards. It serves to advance gender equality not only inside academic settings but also in broader societal contexts.

Limitations and Obstacles

Resistance to the integration of gender-focused research inside academic circles and institutions has been observed, resulting in its occasional marginalisation (Mikell, 1997). The act of oversimplification is a potential danger in the context of gender issues, as it may lead to the essentialisation of these matters or the tendency to see them in isolation without considering the intricate interplay with other overlapping identities, such as ethnicity, social class, or religious affiliation.

There is also the persistent issue of potential Western influence. It has been argued by certain scholars that the models and theories utilised in certain contexts may exhibit a bias towards Western perspectives, perhaps lacking a complete alignment with the African setting (Nnaemeka, 2005).

For Black/African students, the benefits have primarily revolved around visibility and representation. They can now see themselves, their mothers, and their communities represented in the curriculum. However, challenges remain. The curriculum's potential Western influence might not always resonate with their lived experiences. Moreover, the diversity of the African continent means that a singular gendered narrative might not be representative of all students.

The integration of gender into the African Studies curriculum through the lens of intersectionality has undeniably enriched the field, providing a more holistic, inclusive, and nuanced understanding of the continent's diverse societies. While challenges remain, the shift towards a more gender-inclusive curriculum has paved the way for a more just and equitable representation of Africa in academia.

African Studies and Gender Studies in the Global Educational Landscape

The Place of African Studies and Gender Studies within the Larger Global Educational Context

African Studies and Gender Studies emerge as crucial interdisciplinary fields within the broader humanities and social sciences spectrum. While Gender Studies interrogates how gender influences societal structures, experiences, and identities, African Studies centres on Africa's histories, cultures, and global connections. Both fields challenge the dominant Eurocentric narratives often prevalent in educational systems and contribute towards a more inclusive and holistic understanding of global issues (Adichie, 2009).

Positioning and Influence of African Studies in Global Educational Systems

African Studies, once relegated to the fringes of academic inquiry, has acquired traction in various global educational systems. Several universities in the United States, Europe, and other regions of the globe have departments or centres devoted to African Studies. Its influence can be observed in increased collaborative research between African and non-African institutions (Zeleze, 2009), curriculum changes where African literature, histories, and perspectives are incorporated into broader humanities and social science courses (Mkandawire, 2005), and cultural exchanges where there has been an increase in exchange programmes and cultural initiatives focusing on Africa.

Challenges in Decolonising Gender Inclusivity

A significant challenge in African Studies is the decolonisation of knowledge (Falola, 2022). When the curriculum is taught from a Eurocentric viewpoint, it can further colonial stereotypes and misunderstandings (Maldonado-Torres, 2007). Despite the growing presence of African Studies in universities outside of the African continent, there is a pressing need to prioritise African voices in these narratives. Additionally, there is an underlying concern about African Studies being treated merely as a symbolic inclusion (tokenism) instead of a fundamental component of the curriculum.

African Studies enriches the global educational landscape by offering diverse perspectives that promote critical thinking and challenge dominant, often biased narratives (Said, 1995). The integration of African Studies and Gender Studies ensures that educational systems are more inclusive, catering to a broad range of student populations and fostering global citizenship. The movement towards decolonising knowledge underscores the need to centre African perspectives, methodologies, and epistemologies in African Studies. This decolonisation push also emphasises the vital role of Black/African scholars in leading and shaping the field while advocating for accurate representation (Falola, 2022). Furthermore, true inclusivity in the study of Africa and the global African Diaspora recognises the vast diversity within African societies, including different ethnicities, religions, and genders, highlighting the importance of the intersection between African Studies and Gender Studies (hooks, 1984).

African Studies and Gender Studies play indispensable roles in the global educational landscape, challenging dominant narratives, promoting inclusivity, and enriching curricula. While there are inherent challenges in their positioning, the opportunities they present for a more holistic, diverse, and inclusive education are undeniable.

Methodology

An online qualitative survey was used to examine the perceptions and outcomes of the "Introduction to African Studies" course by involving students from the University of Environment and Sustainable Development (UESD). This university was purposively chosen, as four of the researchers taught this course in this university and were interested in learning how students from various disciplines felt about "Introduction to African Studies" being a mandatory course. The researchers also chose this university because of the African and Gender Studies curriculum that the researchers feel can be replicated in other public colleges and universities in Ghana and beyond. With the help of a literature review and discussions among experts teaching the course, an open-ended questionnaire was designed and administered to avoid restricted responses from the students.

All Level 200 students who took the course during the January to May 2023 session were included in the study. A pilot study was carried out with 10 students, and the outcome aided in the amendment of the final questionnaire. The questionnaire was administered via a Google Forms link to the entire class of 88 students of which 50 students responded. The qualitative responses were analyzed thematically using the Braun and Clarke (2006) approach, which involved carefully reading the responses to become familiar with them, creating codes to represent meanings and patterns, grouping the responses according to these codes, sorting codes into various themes, as well as reviewing and revising these themes to produce the narrative forms that were presented in the findings section. The coding process evolved until the responses reached a theoretical saturation point (Cresswell, 2012) where no new concepts evolved further.

Findings and Discussion

The purpose of this study is to assess if the university-mandated "Introduction to African Studies" course is relevant to the students' fields of study, how students view the relation of this course to their fields of study, and to reassess and revise the course to fit the current environment. In general, there is a broad misconception about the discipline of African Studies, with many believing that it is inappropriate to study and will not lead to employment upon graduation (Sackey, 2014). As a result, students opted for the most employable programmes like those emphasising technology and business. However, since the independence era, the Ghanaian government recognised the importance of African Studies for students in all academic fields and made it a requirement for all public universities and public colleges. It is in this context that this study was conducted to find out the perceptions of students on the relevance and outcome of this course across disciplines.

Profile of the Respondents

Participants in this study were undergraduate students from Level 200 at UESD, representing ten different degree programmes. The largest percentage of students were from the Bachelor of Science Programme in Environment and Public Health (32%), followed by the Bachelor of Science Programme in Sustainable Development (20%), the Bachelor of Science Programme in Geography and Earth Science (12%), the Bachelor of Science Programme in Chemistry and Biological Sciences (10%), the Bachelor of Science Programme in Energy and Resource Economics (6%), the Bachelor of Science Programme in Energy Sustainability (6%), the Bachelor of Science Programme in Environmental and Sustainability Science (6%), the Bachelor of Science Programme in Water Resources Development (4%), the Bachelor of Science Programme in Environmental Economics and Policy (2%), and the Bachelor of Science Programme in Nature Conservation and Management (2%) (See Fig. 1). An equal number of male and female students chose to participate in this study.

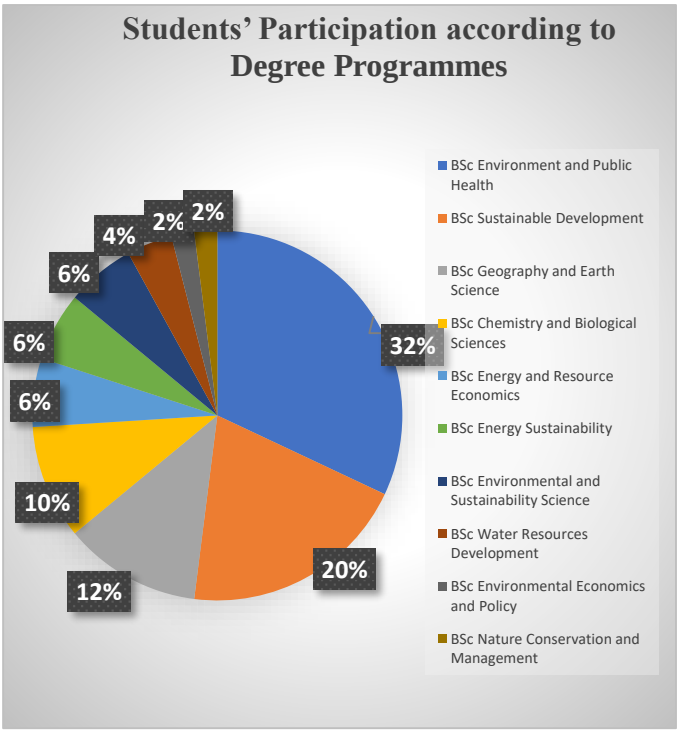

Figure 1: Percentage of Students' Participation according to their Degree Programme

Tertiary Students' Perceptions of the "Introduction to African Studies" Course Incorporating Gender Concepts as a Mandatory University Requirement

The perception and outcome of the students were presented under four themes: (i) Relevance of the course, (ii) Being a mandatory course across disciplines, (iii) Methodology/Course delivery and (iv) Outcome of the course towards Africa's development.

Relevance of Studying African and Gender Studies Curriculum according to Students

Seventy-six percent (76%) of the students thought that the "Introduction to African Studies" course was about the history, culture, and politics of the African continent and would provide in-depth knowledge

about the major issues impacting the African continent. This course has an interdisciplinary approach to understanding the experiences of African people that helps students understand the diversity of African civilisations. There were more positive responses about the course and these included the following statement: It is an important course, and all students must take it seriously, [and] [i]t is a more important course that provides [a] broader understanding of African culture, history and contemporary issues.

Three viewpoints came into focus when the subject of the relevance of studying African Studies was posed: (i) to comprehend the diversity of African culture and the continent's origins and history; (ii) to affirm African identity; and (iii) to dispel prejudice and misconceptions. Fifty-three percent (53%) of students agreed that newer generations should learn about Africa's history and culture in order to preserve the depth and positive aspects of their customs and culture; they also believed that it is relevant because it has the potential to empower African students by providing a platform for them to explore and affirm their identity which makes them proud to contribute to the development of Africa. The "Origin of Humanity" and "Classical African Civilisations" were among the topics covered by this course that were particularly impactful in terms of relevance to students. One student said that it was helpful to understand that civilization didn't just start in White people's land[s;] it even started in Africa.

Another student agreed that the course was relevant, saying that it helped to shape our thoughts and our way of doing things in the positive direction. Students who take this course will also learn how to dispel common myths and stereotypes about African culture. As a result, this course is more pertinent for the younger and upcoming generations since it fosters a sense of identity that motivates students to give back to their society and offers information and skills to help shape a promising future for Africa and its emerging leadership, which was also found by Harper (2009) who observed that African and diasporic existential experiences of Black students enable them to see themselves represented in critical academic discourse and become active agents in resisting oppression (hooks, 1994).

When asked about studying gender themes in "Introduction to African Studies," students gave very positive responses. They added that it is beneficial to be aware of the long-standing gender-based prejudices and discriminations present not only in African society but also throughout the rest of the world. Students believe that learning about gender concepts will help them better comprehend gender issues in African society, particularly the oppression and exploitation of women and girls, as well as the social systems that sustain these inequalities. Students remarked that it will teach them about their rights and freedoms, about respecting one another, and about avoiding gender bias and stereotypes. When questioned about the importance of gender concepts in African Studies for students in different disciplines, students provided positive responses that included the following: Gender shapes our societies and social interaction[s] and hence need[s] to be studied to overcome the bias and stereotypes, [and] [i]t helps boost our confidence and hence it is much more needed for girls across disciplines.

Students' observations intersect with those of the African feminist writer Chimamanda Adichie, who, as observed by Falola (2022),

… uses her work to acquaint the average African woman with ongoing developments in gender relations and the new identity of the woman in a postmodern environment. Her ideologies of resilience, boldness, and self-sufficiency are embodied by the protagonist Ifemelu [from the novel

Americanah (2013)], who is not hemmed in by the constructs of religion or culture but possesses a mindset that transcends such limitations. (pp. 478-479)

Students also responded that it helps them to understand their own gender identity to engage in social activism, question the existing gender norms, gender roles, and power structures, and advocate for gender equality and a just society.

"Introduction to African Studies" as a University-Wide Mandatory Course

"Introduction to African Studies" is a university-required course for students from all disciplines. It is a foundational course that delivers knowledge about African history, culture, and contemporary issues along with gender concepts and gender issues in Africa. Students were asked about how they felt about taking this mandatory course to earn a degree from the university. A few of them reported feeling compelled to take the course, and 78% of them said that they did not feel compelled but were excited to learn, as it fosters critical thinking, global and local perspectives, and social responsibility. A student responded that ultimately individual students' feelings about a required course can vary based on their personal interests, goals, and academic motivations. However, even if it is first viewed as a prerequisite, it is worthwhile to consider the potential advantages and chances that such a course can offer.

Hakim (2023) noted while students generally provided a positive evaluation of university-wide courses, their support within discipline-specific departments was more varied. While 98% responded positively when asked about the university-wide mandatory course in the university overall, some were less positive about it from their specific disciplinary perspectives. The statement "I feel that [the] African studies course should be something that all individuals should learn [in order] to maintain peace and stability in the society" was made by another student. Students believe that making African Studies a required course helps in dispelling biases, stereotypes, and misconceptions about Africa and women. Additionally, it encourages the study of African culture and history from a variety of disciplinary perspectives. Finally, it helps in the development of the African people worldwide by incorporating African and gender perspectives into academic disciplines.

Nyerere agrees with the respondents as he mentioned the benefits of the African educational system critically teaching its own history, culture and values. He said,

But it is no use our educational system stressing values and knowledge appropriate to the past or to the citizens in other countries; it is wrong if it even contributes to the continuation of those inequalities and privileges which still exist in our society because of our inheritance. Let our students be educated to be members and servants of the kind of just and egalitarian future to which this country aspires. (Abraham, 2022, p. 23)

Methodology of Teaching African and Gender Studies Curriculum

The teaching method is essential for student engagement and effective learning. It is increasingly crucial to use a variety of teaching techniques and strategies to enhance students' learning experiences. According to Bear and Skorton (2019), "When students can understand and make connections across a diverse array of knowledge and skills, they embark on a path to more rewarding lives and employment opportunities. Higher education can and must do a better job of leading the way out of disciplinary silos" (Bear and Skorton, 2019, p. 60). The following approaches were indicated by students as being utilised by the multiple instructors to teach the course: lectures, multimedia (films,

documentaries), group activities, group presentations, and artistic performances (music, dance, and theatre). Ninety-six percent (96%) of the students gave the course's delivery method positive reviews, using words like "*excellent*", "*interesting*", "*great*", "*impressive*", "*perfect*", "*fun and effective*", "*creative*", and so on. They enjoyed every session, but the art performance, multimedia, and group activities were their favourites. With the use of these diverse techniques, students were able to comprehend a variety of subjects in a way that was clear, better, and simpler for them to recall. An answer from a student was, The art performances and all of it made it more practical and more fascinating and assisted in producing additional insights on the course itself. My understanding of the course improved with the addition of multimedia and other elements.

One more student remarked, It was a good one, especially with the usage of videos for several of the lessons. Since it is simpler to recall, I believe that watching things helps them stick better than reading. Since there were different lecturers to teach each subject area, I also believe that the teaching methodology was effective. I was quite proud of the cooperation and solidarity among the lecturers.

Six percent (6%) of the students, however, argued that art performances and presentations should be encouraged more than lectures because they assist in better understanding the concepts.

Each approach is crucial since it contributes significantly to the delivery process. Lectures work well for explaining ideas, as they provide opportunities for presenting key concepts, theories, and thoughts related to the subject. Videos, pictures, and documentaries are all forms of multimedia that help give students relatable and better-understood real-world examples. Group activities help students to participate and learn through their peers. It helps in the exchange of ideas, interaction, and working together to solve problems. Presentations help students present the topic creatively and build boldness to communicate effectively. Art performances are a creative approach that help students explore cultural expressions related to what they learn in the classroom. It is a powerful medium to explore and understand African culture, histories, identities, gender issues, etc.

Benefits and Outcome of the Course Towards Africa's Sustainable Development

Although 94% of the respondents were unable to connect "Introduction to African Studies" directly to their field of study, a student, studying environment and public health education, stated that [the] knowledge acquired from studying African and gender perspectives and measures will be used to establish [the] mental and social well-being of an individual or [the] population [at large].

In terms of the impact the course has made on students, 74% stated how the course had positively impacted their behaviour, such as the following: it has made me … self-discipline[d][;] has helped [change] certain perspectives[;] understood all gender[s are] … equal and no one is above each other[;] being a female, I'm now inspired to explore more in my field[;] it helped me to relate well with other[s][;] it helped to value and respect female gender[; and so on].

These results are consistent with Aslam and Khan (2023), which showed that Gender Studies programmes assisted students in comprehending and deconstructing their attitudes, beliefs, and thoughts. The students' attempts to reframe their ideas and views towards particular social issues also opened up new opportunities and resulted in a positive attitude change. For example, regarding recent UESD Students' Representative Council (SRC) positions that were being vied for during the second semester of the 2022/2023 academic year,

57% of the candidates were female students; the results were great though only two offices were won by females, with one of those offices being designated for females only (i.e., Women's Commissioner position). There was a female aspirant for the SRC Financial Secretary position, and the results showed that out of the 523 votes cast, a male aspirant won the contest by a margin of only 28 votes. Another female aspirant for the SRC Public Relations Officer position received just 6 votes less than the male aspirant who won the contest (Electoral Commissioner, 2023). The SRC election results suggest that female students taking up leadership roles in SRCs is not looked down upon in present-day Ghana as it was in the past (Dei et al., 2006). The ultimate aim of this course is to transform students' perspectives, enabling them to develop their own identities and contribute to the development of their local communities and the continent of Africa as a whole. From the analysis, it is well demonstrated that the students' perspectives have changed and started to bring theory into action, which is a good sign for Africa's sustainable development, thus aligning with the findings of McDougal (2021), McDougal and Fischer (2018), Adams (2014), and other scholars about "the *Africana Studies effect*" (or the "Black Studies effect") which improves Black/African students' academic performance, positively transforms students' self-conceptualisation, and cultivates students' agency inside and beyond institutions of higher education.

Knowledge about Africa and gender is essential in the contemporary world and should be instilled in students and the younger generation in order to change perceptions and encourage thinking and acting in favour of an equal and equitable society (Association of African Universities, 2024). Ninety-four percent (94%) of the students agree that prioritising gender and African issues in the production of knowledge will support the sustainable development of Africa. Gender issues must be addressed because when all genders are treated equally and given equal chances in the economy, healthcare, and education, progress towards economic development happens and accelerates the growth of Africa. According to Diop (2015), "As the continent strives to achieve the structural transformation of its economy in order to achieve its agenda 2063 [as charted by the African Union], a greater understanding of the strong linkages between gender equality and sustainable development is a condition *sine qua non* [i.e., 'an essential condition or requirement'] for its socio-economic transformation" (Diop, 2015, p. 1; Collins English Dictionary, n.d.). The knowledge of gender issues will help develop gender-sensitive policies and programs that will help stop gender prejudice, misconceptions, stereotypes, discrimination, and violence. It will also help reposition men and women as a means of mainstreaming gender to establish an equal and just society (Ndlovu-Gatsheni, 2024, pp. 127-128). This was understood by the students. According to a student, [People will work with happiness and will always love to work to increase productivity … when there is equality and equity [,which is accurate and urgently needed].

Limitations of the Study

The study has some limitations due to the smaller sample size and the selection of one public institution purposively. Future studies can be carried out with larger sample sizes and should include public and private tertiary institutions, not only in Ghana but in other African countries. This will give multinational, multiregional, multicultural and multiethnic perspectives about undertaking African Studies courses, which are important components of the ongoing effort to sustain African values and culture which contribute to Africa's development. The study also assessed students' perceptions at the conclusion of the course; future studies with a similar focus can provide valuable insight into more specific

details about the *development* of Black/African students' perceptions and outcomes in developing contexts. Another limitation of the study is the potential bias in self-reported data, as students might have provided responses they perceived as socially desirable or aligned with the expectations of the curriculum. One concern with the study is that students may have given answers they thought were "right" or what the teachers wanted to hear, which could make the results less accurate (see the Appendix for a survey conducted by the student researchers).

Conclusion

African and Gender Studies curriculum in Ghana plays a significant role in the enhancement of Black/African students' understanding and appreciation of the African people inside and outside the African continent (Stewart, 2024). The study examined students' perceptions of and outcomes from an African and Gender Studies curriculum, "Introduction to African Studies", in relation to Africa's sustainable development. The perceptions of the students were presented under four themes: (i) Relevance of the course, (ii) Being a mandatory course across disciplines, (iii) Methodology/Course delivery, and (iv) Outcomes of the course towards Africa's development. An open-ended questionnaire was designed and administered to gather the students' responses on the topic. The results of this study indicate that Black/African students were very satisfied with taking the introductory African Studies course as a part of the required curriculum at a public tertiary institution. These students came to envision themselves as agents directly invested in the historical and contemporary efforts to "decolonize the curriculum" (Falola, 2022, p. 18) of African Studies and other areas of study in universities and colleges across Africa and beyond. The results indicate how students really feel after taking the African Studies course. Indeed, the results suggest that the course may have contributed to the number of female students seeking leadership positions in the institution, as female students appear to now think less about how others may perceive them. "Introduction to African Studies" at UESD inspires students from all disciplines at the university to acquire African-centred knowledge that can be used to contribute to the sustainable development of Africa from non-Eurasian and non-sexist perspectives.

Future research on the impact of "brain drain" and its relationship to contemporary higher education in Africa can benefit from considering and measuring the relevance of African and Gender Studies curriculum to Black/African students' knowledge acquisition in all areas of study, providing data that could lead to a more comprehensive understanding of the problematic trend of graduates from African institutions of higher learning seeking what they perceive to be greener pastures outside the African continent (Jack, 2024).

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Appendix

African Studies Survey: Perspectives and Insights. The following survey was conducted solely by students. All responses are presented unedited.

A survey was conducted which involved three students in relation to African Studies to gather their thoughts and opinions on the field. This report summarizes their responses, providing insights into the perceptions, challenges, and opportunities in African Studies. Our goal is to share their

perspectives and foster a better understanding of the field with no interference of lecturers, as it may affect their responses.

Below are the set of questions the students were asked based on their understanding of African Studies.

1. What comes to your mind when you think of African Studies?
2. How do you think African Studies challenges or reinforces dominant narratives about Africa and its people?
3. What are some common misconceptions about Africa or African studies that you've encountered, and how do you think they can be addressed?
4. How do you think African studies can be more inclusive of gender perspectives and address gender-related issues in the continent?

The answers to the above questions are stated below in accordance with each student.

1. What comes to your mind when you think of African Studies?

1st Student: African studies is the field that deals with the study of African society and their culture.
2nd Student: African studies basically means learning about our culture and heritage, and how that knowledge can help us further, in the future.
3rd Student: African studies describes the studies about our lost culture and traditions.

2. How do you think African Studies challenges or reinforces dominant narratives about Africa and its people?

1st Student: African studies provides insights into the history and development of the African society. The African people get to know more about their backgrounds and cultural values. Also, the Western society gets to know more about the African setting, knowledge about one's origin and culture, which helps gain confidence and share his/her cultural values with others.
2nd Student: Well, knowing our heritage is important. Besides, the modern impact it has had on our present generation brings us back to who we used to be and guides us to follow who we are.
3rd Student: The design of the perspective course outlines the history and origin of traditional African leadership among others.

3. What are some common misconceptions about Africa or African studies that you've encountered, and how do you think they can be addressed?

1st Student: Majority of the studies concerning the African community and their norms are carried out by the Western society. There is the possibility of slight alterations in their reporting, tarnishing the African setting. This can be addressed by encouraging Africans to take interests in their own history and culture.
2nd Student: One misconception I've encountered is that the knowledge we obtained from our past African heritage is outdated and does not help in the present generation. This is in the sense that, African studies give a fair idea of who we are and how our heritage makes us different from other cultures around the world. In conclusion, I think that African studies should be a key study everywhere we go and should be in our various educational institutions, which may help foster and improve our heritage.
3rd Student: One misconception I encountered is the saying that African culture is against human right. This statement proves the fact that the inability to expose our heritage publicly may generate false theories and hence, African culture must be brought to light.

4. How do you think African studies can be more inclusive of gender perspectives and address gender-related issues in the continent?

1st Student: African studies programs can expose students to the way in which gender dynamics shape the various aspects of the African society. This can be done by examining the roles of men and women in the various contexts such as cultural, political, and economical contexts.
2nd Student: African studies can be more inclusive by adding gender-focused classes, and teaching about gender issues in Africa, listening to both men and women's perspectives, and exploring how gender affects people's lives in different ways.
3rd Student: African studies should look at how gender affects people's lives in different ways and highlight the stories of women and other marginalized groups. This will help us understand Africa better.

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CLIMATE CHANGE AND VULNERABILITY AND RESILIENCE OF MANUFACTURING SUPPLY CHAINS IN NIGERIA

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Abstract

Climate change is a pressing global issue with far-reaching implications for various sectors, including manufacturing supply chains. Given the Nigeria diverse geographic and socioeconomic landscape, understanding the presence or absence of cross-sectional dependence within the manufacturing sector will be crucial for implementing effective policy measures and business strategies. Hence, the main objective of this study it to investigate the impact of climate change on manufacturing supply chains in Nigeria using the survey research design. The sample comprised 320 employees and other stakeholders in the manufacturing industry selected through the stratified sampling technique. Instrument used for data collection was a structured questionnaire. Two hypotheses were formulated and tested by means of simple linear regression analysis at the .05 level of significance. Results revealed that climate change has a significant impact on the vulnerability of manufacturing supply chains ($\beta = 0.263$, $t = 13.268$, $p < .05$) and climate change has a significant impact on the resilience of manufacturing supply chains in Nigeria ($\beta = -0.227$, $t = -11.469$, $p < .05$). Based on these findings, it was concluded that climate change significantly impacts the vulnerability and resilience of manufacturing supply chains in Nigeria, with a positive relationship to vulnerability and a negative relationship to resilience**.** It was subsequently recommended, among others, that the management of manufacturing supply chains in Nigeria should proactively develop and implement climate change adaptation strategies such as conducting vulnerability assessments to identify specific risks and vulnerabilities posed by climate change.

Key Words: Climate change, vulnerability, resilience, manufacturing supply chains.

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Introduction

Climate change is a pressing global issue with far-reaching implications for various sectors, including manufacturing supply chains. Climate change refers to the long-term alteration of the earth's average weather patterns, particularly changes in temperature and weather events, which emanate from both natural phenomena and human activities. The major cause of climate change is the increased accumulation of greenhouse gas concentrations in the atmosphere, primarily carbon dioxide (CO2) from burning fossil fuels, deforestation and other industrial activities. These greenhouse gases trap heat, leading to the "greenhouse effect" and global warming (Intergovernmental Panel on Climate Change, 2014). Manufacturing supply chains are the interconnected networks of organizations, processes, resources and technologies involved in the production and distribution of goods. They encompass all the activities required to transform raw materials into finished products and then deliver them to the consumers or other firms (Chopra & Meindl, 2015). According to Monczka, Handfield, Giunipero, and Patterson (2020), supply chains typically involve multiple stages, including sourcing raw materials, manufacturing, assembly, quality control, packaging, warehousing, transportation and distribution. The aim is to optimize the flow of materials and information throughout the entire process, minimizing costs and lead times while maximizing efficiency and customer satisfaction.

The vulnerability and resilience of manufacturing supply chains to climate change impacts have gained significant attention in recent years. Nigeria, as a developing country located in West Africa, is particularly susceptible to the adverse effects of climate change due to its geographical location and socio-economic characteristics. The Intergovernmental Panel on Climate Change (IPCC) has highlighted the increasing frequency and intensity of extreme weather events such as droughts, floods, and heatwaves as key consequences of climate change (IPCC, 2014). These events pose significant risks and disruptions to manufacturing supply chains, leading to potential economic losses, production delays, and disruptions in the flow of goods and services.

Climate change is expected to have far-reaching effects on global supply chains, disrupting production, distribution and transportation systems. Extreme weather events, rising temperatures, changing precipitation patterns and sea-level rise can lead to supply chain disruptions, increased operational costs and reduced efficiency (Gupta, Lim, & Rana, 2020; Pettit, Harris, Beresford, & Zhang, 2018; Rehman, Gligor, & Kovács, 2017).

Assessing the vulnerability of manufacturing supply chains to climate change involves understanding the exposure, sensitivity and adaptive capacity of the system (Fletcher, Gemenne, & Tan, 2018; Wang, Sarkis, & Zhang, 2020). Exposure refers to the degree of climatic changes and associated hazards faced by the supply chain. Sensitivity relates to the supply chain's susceptibility to these changes due to its characteristics, location, and dependencies. Adaptive capacity reflects the ability of the supply chain to respond and recover from climate-related disturbances (Raza, Raza, Shahbaz, & Zafar, 2021).

Resilience is a crucial concept in managing climate change risks in supply chains. Building resilience involves developing adaptive strategies and implementing robust risk management practices to enhance the ability of supply chains to withstand and recover from disruptions (Islam, Meade, & Sarkis, 2019; Wang, Sarkis, & Li, 2018). Resilience measures may include diversifying sourcing locations, implementing climate-responsive logistics

systems, fostering collaboration among supply chain partners, and integrating climate change considerations into business continuity planning (Khan, Sarkis, J., & Geng, 2020; Mishra et al., 2019)

Understanding the specific vulnerabilities and developing strategies to enhance resilience are crucial for the sustainable development and continuity of manufacturing supply chains. This study aims to investigate the climate change vulnerability and resilience of manufacturing supply chains in Nigeria, providing valuable insights for policymakers, industry stakeholders and researchers.

The research gap in this study can be identified as the lack of specific, localized studies that explore the impact of climate change on the vulnerability and resilience of manufacturing supply chains in Nigeria. Although global and regional studies exist, there is a need for focused research that examines the unique challenges and dynamics faced by Nigerian manufacturing supply chains in the context of climate change. There is limited research specifically addressing how climate change affects manufacturing supply chains within the Nigerian context, considering the unique socio-economic and environmental conditions of the country. There is also a lack of detailed, practical climate change adaptation strategies designed for the Nigerian manufacturing sector. Finally, there are insufficient studies involving a wide range of stakeholders within the Nigerian manufacturing industry to comprehensively understand their perspectives and challenges related to climate change.

The research problem in this paper is therefore the significant impact of climate change on the vulnerability and resilience of manufacturing supply chains in Nigeria. The problem is characterized by an increase in the vulnerability of manufacturing supply chains by climate change, a significant negative impact of climate change on the resilience of manufacturing supply chains and a need for structured vulnerability assessments and the development of specific adaptation strategies. By addressing these issues, this study can provide valuable insights and recommendations that can help the Nigerian manufacturing sector to better prepare for and respond to the challenges posed by climate change.

Research Objectives

The main objective of this paper is to examine climate change vulnerability and resilience of manufacturing supply chains in Nigeria. The specific objectives are:

1. to assess the current state of manufacturing supply chains in Nigeria and highlight the negative impacts of climate change.
2. to evaluate the potential risks and impacts of climate change on manufacturing supply chains, including extreme weather events, resource scarcity, and infrastructure disruptions; and
3. to provide recommendations and guidelines for policymakers, industry stakeholders and supply chain managers to enhance the climate resilience of manufacturing supply chains in Nigeria.

Research Questions

1. 1.Does climate change have a significant impact on the vulnerability of manufacturing supply chains in Nigeria?
2. Does climate change have a significant impact on the resilience of manufacturing supply chains in Nigeria?

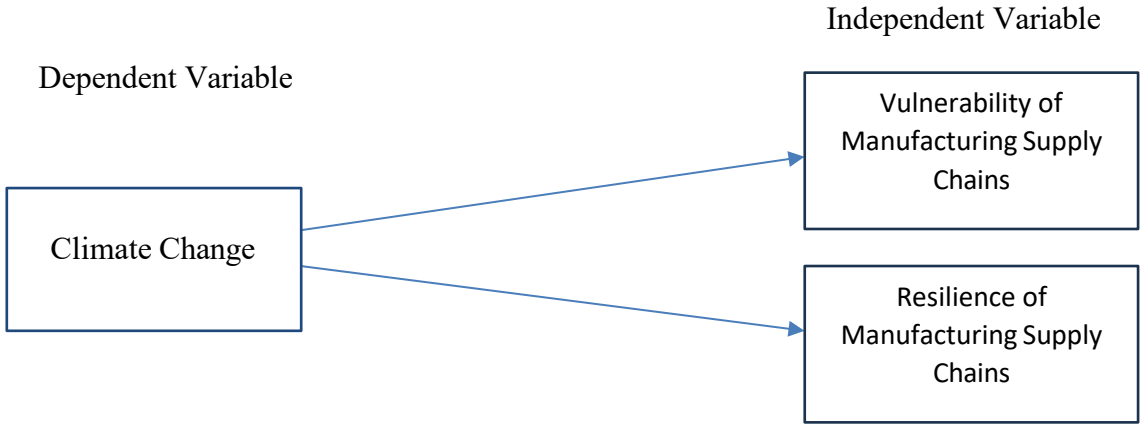
Hypotheses

H1: Climate change has significant impact on the vulnerability of manufacturing supply chains in Nigeria.

H2: Climate change has no significant impact on the resilience of manufacturing supply chains in Nigeria.

Conceptual Framework

The conceptual framework demonstrates that climate change (the independent variable) affects the vulnerability (the first dependent variable), and resilience (the second dependent variable) of manufacturing supply chains in Nigeria. This is illustrated in Figure 1.



Justification of the Study

This study is justified by several reasons. Firstly, climate change is a pressing global issue, with far-reaching implications for the manufacturing sector. Secondly, as a developing country with a robust manufacturing sector, Nigeria is vulnerable to climate change due to its geographical location and socio-economic characteristics. Thirdly, although several studies have been carried out on climate change and supply chains globally, studies focusing on Nigeria are rare. The country's ability to maintain and improve its manufacturing supply chains is vital for its economic stability and growth. Finally, manufacturing is an important sector in Nigeria's economy. Disruptions in supply chains due to climate change can lead to serious economic losses, production delays and disruptions in the distribution of commodities. All these gaps provide justification for this study.

Literature Review

The Concept of Climate Change

The World Meteorological Organization in 1966 proposed the term climatic change to encompass all forms of variations in the climate variability on timescales of greater than 10 years, whether the cause was natural or anthropogenic. When it was realized that human activities had a potential to drastically alter the climate, the term climate change replaced climatic change as the dominant term to reflect an anthropogenic cause. Climate change was incorporated in the title of the Intergovernmental Panel on Climate Change (IPCC) and the UN Framework Convention on Climate Change (UNFCCC). Since 1988, the IPCC has produced 5 multivolume reports which collate the consensus of all leading scientists across the globe on all aspects of the science of climate change (Geoffrey, 2017).

Climate change refers to changes in the earth's climates, at local, regional, or global scales, and is most used to describe anthropogenic, or human-caused, climate

change (Hayhoe, 2019). In other words, climate change is used to describe changes in the earth's climate caused mainly by human activities such as the burning of fossil fuels (coal, oil and gas) and deforestation resulting in an increase in the concentration of carbon dioxide in the atmosphere (El-Sheikh, 2022). It can bring about long-term changes in temperatures and weather patterns.

"Global warming" is a term that is commonly used synonymously with climate change. It refers to the rise in average global temperatures, which can pose significant hazards to human life, wildlife and ecosystems. Burning fossil fuels generates greenhouse gas emissions that act like a blanket wrapped around the earth, trapping the sun's heat and raising temperatures. There is strong consensus among climate scientists that human activities have been the major cause of observed warming trends since the 20th century (Rainforest Alliance, 2018). Surface temperature increase in Nigeria has been found to be correlated with greenhouse gas emissions which can cause rise in sea level. Rise in sea level in turn can trigger coastal erosion, flooding, saltwater intrusion, mangrove degradation and other related socio-economic problems (Akintoye & Adedokun, 2023).

Climate Change, a result of global warming, is a reality of universal acceptance, affecting in many ways the life of human societies, business operations and the environment itself (Stern Review, 2016). In fact, businesses must perform their climate change-prone operations in a more vigorous and riskier environment where institutional, resource-based, supply chain and stakeholder views are all important to characterize and understand corporate strategic responses to a sustainability issue (Ibrahim & Udo, 2024). According to (Oluwole & Adeyemi, 2023), there are three types of climate change risks that can affect business: risks to core operations, risks to the value chain and, finally, risks that arise from broader changes in the economy and infrastructure. Moreover, climate change mitigation and adaptation policies may further affect business operations in a rather indirect way. Businesses should think of climate change as a market issue as regulations towards climate change affect, among others, energy prices and availability, thus, creating a ripple effect throughout their entire value chain (Adamu & Hassan, 2024). Market issues and relevant market strategies should be taken into consideration when companies draft climate change policies (Adamu & Hassan, 2024).

Manufacturing Supply Chains

A manufacturing supply chain refers to the interconnected network of organizations, activities, resources, and processes involved in the production and distribution of goods or products. It is a dynamic and complex system that aims to ensure the timely, cost-effective and reliable flow of materials and products from the initial sourcing of raw materials to the delivery of finished goods to customers. Manufacturing supply chains typically involve multiple stages, including procurement, production, logistics, and distribution. They encompass various entities such as suppliers, manufacturers, wholesalers, retailers, and transportation providers, all working together to ensure the smooth and efficient flow of materials and products. The key components of a manufacturing supply chain include suppliers, manufacturers, logistics and distribution and customers (Adebanji, Oyewunmi, & Afolabi, 2020).

Climate Change and Manufacturing Supply Chains

Climate change impacts industrial supply chains through various channels, including extreme weather occurrences, resource

availability, and evolving market dynamics. The Intergovernmental Panel on Climate Change (2014) underscores the importance of assessing vulnerability and establishing resilience to adapt to these repercussions.

In the present volatile environment, climate change alters the competitive landscape for manufacturing firms. Consumers increasingly demand high-quality products and services at competitive prices, while also valuing environmental considerations such as carbon footprint and energy efficiency (Okoro & Eze, 2023). Companies that fail to integrate this message into their supply chain strategy or neglect to address climate change concerns will inevitably face repercussions from environmentally conscious customers. Moreover, recognizing that "supply chains compete, not companies" (Adebanjo & Olaniyan, 2024), it becomes evident that Supply Chain Management (SCM) will play a pivotal role in meeting the evolving demands of customers in the context of climate change. Employing an appropriate supply chain strategy becomes imperative for firms to fully capitalize on the opportunities presented by climate change while mitigating associated threats. In the era of low carbon emphasis, it appears that low-carbon SCM will serve as the driver for enhancing competitiveness (Yang & Zhang, 2011). Regulatory, physical, and market influences stemming from climate change create both challenges and prospects for supply chains.

Vulnerability of Manufacturing Supply Chains in Nigeria

Climate change introduces significant uncertainties into supply chain networks, particularly those that operate globally across multiple continents. As revealed by McKinnon (2009), the concentration of inventory over the last four decades has amplified the vulnerability of supply chains to extreme weather phenomena like flooding. Hence, it becomes very important to account for climate change risks during the initial design phase of supply chain networks to safeguard them from potential disruptions and susceptibilities to both physical and regulatory instabilities.

Addressing supply chain strategic considerations, five key clusters of implications emerge: facility location, product design, transportation and distribution, sourcing, and supply chain network configuration. Regarding supply chain configuration, the lean, agile, and leagile paradigms have been identified as the most prevalent paradigms under which supply chains can be structured and operated (Adebanjo & Olaniyan, 2024; Geoffrey, 2017).

Determining which of the three paradigms is more environmentally friendly and accounts for fewer emissions poses a complex challenge. For instance, whether the lean paradigm aligns with green principles lacks scientific consensus (Geoffrey, R.M. (2017)). Similarly, it is challenging to ascertain which paradigm is more susceptible to the stresses brought about by climate change. Each paradigm has its unique characteristics, leading to diverse exposure levels to climate-related hazards. Consequently, in the context of climate change, all three paradigms face mounting pressures as their building blocks' configuration demands a predefined level of synchronization and alignment. Furthermore, aspects of coordination, collaboration, and information sharing may also emerge. While substantial changes in the configuration of supply chains might not result directly from climate change, adjustments that reduce vulnerabilities and confer competitive advantages should be implemented. These adjustments stem from the differential vulnerability levels presented by their building blocks in the face of climate change hazards. Certain supply chain configurations capable of absorbing adverse climate change

effects could indeed confer a competitive edge.

Studies indicate that manufacturing supply chains in Nigeria grapple with diverse vulnerabilities linked to climate change. Akpan (2018) underscores the risks linked to severe weather events, such as flooding and heatwaves, which have the potential to disrupt transportation infrastructure and harm production facilities. Additionally, Essien (2020) emphasizes the susceptibility of supply chains to water scarcity, considering Nigeria's uneven distribution of water resources.

Drivers of Vulnerability

Geographical location, sector-specific characteristics, and reliance on scarce resources are identified as key drivers of vulnerability within manufacturing supply chains. Ologunde (2019) suggest that coastal manufacturing supply chains in Nigeria face heightened risks due to rising sea levels and coastal erosion. Furthermore, Olawoye and Elegbede (2021) highlight the vulnerabilities associated with resource-intensive industries, such as energy-intensive manufacturing processes.

Resilience Strategies

Research reveals several strategies for enhancing the resilience of manufacturing supply chains in Nigeria. These include diversifying sourcing locations (Nwachukwu 2019), implementing contingency plans for disruptions (Adebanji *et al.*, 2020), and adopting green technologies to reduce environmental impact (Ismaila, 2021). Furthermore, government policies and support mechanisms, such as renewable energy incentives and climate change adaptation plans, are identified as crucial in promoting resilience (Adelekan, Fayeun, & Johnson, 2020).

Collaborative Networks

Collaboration and information-sharing among stakeholders within manufacturing supply chains are essential for building resilience. Studies emphasize the role of partnerships between manufacturers, suppliers, customers, and governmental agencies in sharing knowledge, resources, and risk management strategies (Okoroh, 2021; Chukwuemeka, 2022). This literature review highlights the importance of understanding the vulnerability and resilience of manufacturing supply chains in Nigeria in the face of climate change. It underscores the need for research and practical interventions to enhance adaptive capacity and mitigate the risks associated with climate change impacts. By incorporating strategies such as diversification, resource optimization, and collaboration, manufacturing supply chains in Nigeria can become more resilient in the face of a changing climate.

Appraisal of Literature and Theoretical Framework

The literature review is adequate, current and recent. It integrates various perspectives on climate change impacts and supply chain resilience (Akintoye & Adedokun, 2023; Okoro & Eze, 2023). The underpinning theoretical framework combines supply chain management paradigms (lean, agile, leagile) with climate change resilience strategies and emphasize the need for adaptive and strategic responses (Adebanjo & Olaniyan, 2024). This framework is highly applicable to the study as it provides a structured approach to understanding and mitigating climate-related vulnerabilities within Nigeria's manufacturing supply chains and highlights the importance of diversification, resource optimization and collaboration (Ibrahim & Udo, 2024; Adamu & Hassan, 2024).

Methods

Research Design

This study adopted a descriptive survey research design and primary data which were collected through surveys or questionnaires. This design enabled the researcher to capture large sample size and employ a questionnaire to gather data for analysis for the purpose of generalizing on the impact of climate change on the vulnerability and resilience of manufacturing supply chains in Nigeria.

Population

The population of interest for this study comprised of all the, approximately 39,600, employees of manufacturing companies in South-West Nigeria.

Sample and Sampling Technique

A multi-stage sampling technique was employed. In the first stage, a purposive sampling method was used to select three states in South-West Nigeria. In the second stage, a list of manufacturing companies operating within these selected States was obtained. Within each stratum, manufacturing companies were randomly selected based on their size, sector and vulnerability to climate change impacts. Stratified random sampling technique was then applied to select a representative sample of 396 employees, selected through the Taro Yamani's formula, from the manufacturing industry. The technique was used because the data meet the following assumptions:

1. The observations within each stratum and across different strata were independent or distinct from one another.
2. There was homogeneity within strata, i.e., the units within each stratum were relatively homogeneous with respect to the variable of interest.
3. There was heterogeneity between strata, i.e., the strata should be different from each other in terms of the variable being studied.
4. Every member of the population could be assigned to one and only one stratum.
5. Each stratum had a sufficient sample size to allow for reliable statistical inference.

Research Instruments

A self-constructed structured questionnaire titled "Climate Change and Vulnerability and Resilience of Manufacturing Supply Chain Questionnaire" (CCVRMSCQ) was used by the researcher. The questionnaire was developed to collect quantitative data on vulnerability and resilience of manufacturing supply chains using the theoretical approach. The questionnaire contains 20 items related to climate change impacts, collaboration among stakeholders, supply chain disruptions and adaptation strategies. It has two sub-scales: Climate Change & Vulnerability of Manufacturing Supply Chains sub-scale and Climate Change & Resilience of Manufacturing Supply Chains sub-scale, with each sub-scale having 10 items. The CCVRMSCQ is a 4-point Likert-type instrument having responses ranging from 1 = strongly disagree to 4 = strongly agree. Sample items on the scale are: 1. *There is an increase in transportation costs or logistical challenges due to climate-related changes (e.g., rising sea levels, changing weather patterns)* and 2. *My organization's manufacturing supply chain can adapt and thrive in the face of climate change challenges*.

Reliability and Validity of the Instruments

The reliability of the instrument was tested using the test-retest method. Consequently, it was administered on a sample of 25 employees of manufacturing organizations in the study area on two separate occasions with an interval of two weeks between the two

administrations. An analysis of the two sets of scores obtained yielded test-retest reliability coefficients of .87 and .81 for the Climate Change & Vulnerability of Manufacturing Supply Chains sub-scale and Climate Change & Resilience of Manufacturing Supply Chains sub-scale respectively. These indices indicate that the items on the CCVRMSCQ are stable over time and the instrument is reliable. To ensure the validity of the research instruments, a thorough literature review was conducted to identify relevant variables and constructs. The questionnaire was also reviewed by experts in the field who determined their face and content validity.

Method of Data Collection

After obtaining ethical approval for the study, data collection commenced. The questionnaires were administered manually to the employees in the selected manufacturing companies while adhering to the ethical principles of informed consent, confidentiality and anonymity. Interested employees were at liberty to complete the survey or refuse to complete it. Of the 396 copies of the questionnaire distributed, 384 were completed and returned. This gave an attrition rate of 3.03%. This indicates a high rate of return.

Method of Data Analysis

Quantitative data obtained from the questionnaires were analyzed using simple linear regression analysis to test the hypotheses at the .05 level of significance. However, descriptive statistics was used to analysis the demographic characteristics of the respondents.

Ethical Considerations

i. Informed Consent: Participants were provided with detailed information about the study's purpose, procedures and potential risks and benefits. Their voluntary participation and right to withdraw at any time without consequence were emphasized. Informed consent forms were obtained from all participants.
ii. Anonymity and Confidentiality: Participants' identities and responses were kept confidential. Data were stored securely and accessible only to the researcher.
iii. Data Protection: All data collected were used solely for research purposes and were securely stored in accordance with data protection regulations.
iv. Ethics *Approval:* This study sought and obtained ethical approval from the relevant institutional review board or ethics committee.

Results

A total of 396 questionnaires were distributed to the respondents both online, using google form, and offline, but 384 responses were received and find valid for analysis, making 97% response rate. Both descriptive and inferential statistics were employed for the analysis, while descriptive was used for the demographic distribution, simple regression was used to test the stated hypothesis, which was also used answer the research questions, at 5% level of significant.

Demographic Presentation

Table 1: Participants' Demographic Data

S/No	Variable	Category	N = 384	Frequency	Percentage
1	Gender	Male		226	58.9
		Female		158	41.1
2	Age (years)	Below 30		72	18.8
		30 – 49		193	50.3
		50 & above		119	30.9
3	Qualification	Below First Degree		93	24.2
		First Degree/HND		189	49.2
		Master's Degree		79	20.6
		PhD		23	6.0
4	Work Experience (years)	Less than 10		84	21.9
		10 - 19		192	50.0
		20 & above		108	28.1

Source: Field Survey, 2024

Table 1 showed the frequency and percentage distribution of participants. It revealed that most of the participants (58.9%) were male while 41.1% of the participants were female. Thus, there were more male than female participants in this study. Most of the participants (50.3%) were 30 – 49 years old. This was successively followed by those who were 50 years old and above (30.9%) and below 30 (18.8%). The greatest proportion of the participants (49.2%) had First Degree/HND qualification. This was successively followed by those who had below First-Degree qualification (24.2%), Master's degree (20.6%) and Ph.D. (6.0%). Finally, exactly a half of the participants (50%) had 10 - 19 years' work experience. This was successively followed by those who had 20 & above years' (28.1%) and less than 10 years' (21.9%) work experience.

Test of Hypotheses

Hypothesis One

Climate change has no significant impact on the vulnerability of manufacturing supply chains in Nigeria.

Table 2: Simple Linear Regression Coefficients for Impact of Climate Change on Vulnerability of Manufacturing Supply Chains

	B	Std. Error	Beta	t	Sig.
(Constant)	3.836	6.108		17.035	.000
Climate Change	.127	.029	.263	13.268	.000

Dependent Variable: Vulnerability of Manufacturing Supply Chains
Source: Field Survey, 2024

Table 2 showed the impact of climate change on vulnerability of manufacturing supply chains. It revealed significant results (β = .263, t = 13.268, p <.0005) leading to the rejection of the null hypothesis and the upholding of the alternative hypothesis that climate change has a significant impact on the vulnerability of manufacturing supply

chains in Nigeria. Table 2 further indicated a significant positive relationship between climate change and vulnerability of manufacturing supply chains (β = .263).

Hypothesis Two

Climate change has no significant impact on the resilience of manufacturing supply chains in Nigeria.

Table 3: Simple Linear Regression Coefficients for Impact of Climate Change on Resilience of Manufacturing Supply Chains

	B	Std. Error	Beta	t	Sig.
(Constant)	2.906	4.574		12.375	.000
Climate Change	-.103	.033	-.227	-11.469	.000

Dependent Variable: Resilience of Manufacturing Supply Chains

Source: Field Survey, 2024

Table 3 showed the impact of climate change on resilience of manufacturing supply chains. It revealed significant results (β = -.227, t = 11.469, $p < .0005$) leading to the rejection of the null hypothesis and the upholding of the alternative hypothesis that climate change has a significant impact on the resilience of manufacturing supply chains in Nigeria. Table 3 further indicated a significant negative relationship between climate change and resilience of manufacturing supply chains (β = -.227).

Discussion

The findings of the study provide significant insights into the impact of climate change on the vulnerability and resilience of manufacturing supply chains in Nigeria. The test of the first hypothesis showed that climate change has a significant impact on the vulnerability of manufacturing supply chains in Nigeria (β = .263, t = 13.268, p <.0005): This indicates a strong positive relationship between climate change and the vulnerability of manufacturing supply chains. The beta coefficient (β = .263) suggests that as climate change intensifies, the vulnerability of supply chains increases significantly. This finding corroborates the assertions made in the literature. For example, Akpan (2018) highlighted the risks posed by severe weather events such as flooding and heatwaves to supply chain infrastructure in Nigeria. Similarly, Essien (2020) emphasized the susceptibility of supply chains to water scarcity, which aligns with the study's findings on increased vulnerability. The positive relationship between climate change and the vulnerability of manufacturing supply chains is supported by multiple studies. McKinnon (2009) discussed how concentrated inventory practices increase supply chain vulnerability to extreme weather events. Ologunde (2019) and Olawoye and Elegbede (2021) further identified geographical and sector-specific characteristics as drivers of vulnerability, which the study's findings reinforce.

The test of the second hypothesis showed that climate change has a significant impact on the resilience of manufacturing supply chains in Nigeria (β = -.227, t = 11.469, p < .0005): This result demonstrates a significant negative relationship between climate change and the resilience of manufacturing supply chains. The beta coefficient (β = -.227) indicates that the increasing impacts of climate change negatively affect the resilience of these supply chains. This finding aligns with existing literature. Research by Adebanji et al. (2020)

and Ismaila (2021) has stressed the importance of adopting resilience strategies, such as diversifying sourcing locations and implementing contingency plans, to mitigate climate-related disruptions. The study's findings underscore the critical need for these resilience-building measures. The negative relationship between climate change and supply chain resilience is in line with the findings of Islam, Meade, and Sarkis (2019) and Wang, Sarkis, and Li (2018). These studies emphasized the importance of adaptive strategies and robust risk management practices to enhance supply chain resilience. The study's findings highlight the critical role of resilience measures, such as collaboration among supply chain partners and integration of climate change considerations into business continuity planning, as recommended by Khan, Sarkis, and Geng (2020) and Mishra et al. (2019).

Finally, the underpinning theoretical framework combining supply chain management paradigms (lean, agile and leagile) with climate change resilience strategies is validated by the study's findings. The need for adaptive and strategic responses, as highlighted by Adebanjo and Olaniyan (2024), Ibrahim and Udo (2024) and Adamu and Hassan (2024), is supported by the demonstrated impacts of climate change on both vulnerability and resilience. Based on these findings, the following recommendations were made:

1. The management of manufacturing supply chains in Nigeria should proactively develop and implement climate change adaptation strategies. This includes conducting vulnerability assessments to identify specific risks and vulnerabilities posed by climate change. Based on these assessments, supply chain managers can develop targeted adaptation plans, such as implementing climate-resilient infrastructure, diversifying sourcing and production locations, and adopting technologies that enhance resilience to climate-related disruptions.
2. Collaboration among stakeholders should be strengthened to build resilient supply chains. Manufacturers, suppliers, logistics providers, government agencies and local communities should foster partnerships and knowledge sharing to collectively address the challenges of climate change. This can involve joint planning, information exchange and coordination to enhance the overall resilience of supply chains. Engaging with relevant industry associations and networks can also provide a platform for collaboration and sharing best practices.
3. Manufacturing organizations should invest in technology and innovation that can help in enhancing the resilience of manufacturing supply chains in Nigeria. Implementing advanced forecasting and risk management tools, utilizing real-time data monitoring and analysis and deploying smart logistics systems can improve supply chain visibility, responsiveness and adaptability. Furthermore, exploring sustainable and low-carbon technologies can help reduce the carbon footprint of supply chains, contributing to climate change mitigation efforts.
4. Capacity and awareness of supply chain stakeholders should be built. This can be achieved through training programmes, workshops and knowledge-sharing initiatives focused on climate change adaptation, risk management and sustainable practices. Raising awareness about the

potential impacts of climate change on supply chains and sharing best practices can empower stakeholders to make informed decisions and take proactive actions to strengthen resilience.

5. Government policies play a crucial role in creating an enabling environment for building resilient supply chains. Governments should therefore develop and enforce regulations that promote sustainable practices, climate change adaptation and resilience-building in the manufacturing sector. Integration of climate change considerations into national and sectoral policies, such as industrial development plans and infrastructure investment strategies can provide a holistic framework for addressing climate-related risks and vulnerabilities in supply chains.

Conclusion

Climate change poses significant challenges to the vulnerability and resilience of manufacturing supply chains in Nigeria. The findings of this study underscore the urgent need for strategic interventions, adaptive planning and collaborative efforts to mitigate the adverse effects of climate change and enhance the resilience of supply chains. By addressing these issues, stakeholders can ensure the sustainable development and continuity of manufacturing supply chains in Nigeria, ultimately contributing to the overall economic resilience and sustainability of the country.

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Assessment of Nigerian Primary School Pupils' Pro-Environmental Concerns and Practices

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Abstract

In Nigeria, evidence on primary school pupils pro-environmental concern and practices are limited, with such information would be helpful in the provision of interventions. Thus, we assessed primary school pupils pro-environmental concern and practices. Eight hundred and thirty-two (832) Nigerian primary school pupils were administered with a questionnaire. Four demographic variables gender, age, class, and school type were tested as possible relationship and difference of pro-environmental concerns and practices. Results of revealed that most of the respondents have moderate concern for environmental issues. There were significant differences in pupil environmental concerns by gender, age, and school ownership. However, no significant difference was found in their' pro-environmental practice. There was significant difference in pro-environmental practice among the classes. It was found that environmental concern positively correlated with pro-environmental practices. Based on the findings some practical recommendations were given.

Keywords: Pro-environmental concerns, practices, primary school, pupils, Nigeria

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Introduction

The first step towards changing to more environmentally friendly practices is raising public awareness or consciousness of environmental issues. Individuals who care about protecting the environment for both present and future generations are more likely to act and behave in ways that support the environment. Cortes et al. (2017), defines pro-environmental behaviour as "way of acting that people consciously carry out to protect, preserve or minimise the negative impacts on the natural environment.". It refers to those behaviours and attitudes that they show and can lead to the manifestation of sustainable and environmentally friendly actions. Reiterating the importance of this, Rincón (2020) opines that pro-environmental behaviour promotes environmental actions capable of reducing significantly the impact caused through people's daily activities.

Balundé et al. (2019) distinguished four categories that are critical to comprehending pro-environmental behaviour. These are "hedonic values, altruistic values, egoistic, and biospheric values. The implication of these is that assessing pro-environmental behaviours of children requires looking at their biospheric value which appeals to their sensitivity to protect their environment based on the quantum of environmental knowledge they possess.

Research have been conducted about environmental concerns and behaviour of different category of learners- undergraduates, secondary school students and elementary pupils. Karatekin (2013) used mind mapping technique to assess 5th to 8th grade elementary school pupils' perception of environmental problems in Ankara, Turkey. The results showed that environmental problems such as global warming, water pollution, air pollution, and poor waste management were the most environmental concerns of the pupils. Ruchliyadi et al. (2023) study, carried out at riverbanks of Banjarmasin City to determine students' concern for the environment, found that students' level of awareness of environmental issues is quite good (63%). Unclean environment is rated as of most serious concern and attitude towards caring for environment is found to be bad.

Other studies have focused on investigation of the factors influencing elementary pupils' pro-environmental behaviours, such as environmental literacy (Ivanova, 2019; Runhaar et al., 2019),' gender, and intentions (Runhaar et al., 2019). These studies have mainly focused on children's cognition of the environment along with individual differences. Although such a focus may lead to an increase in children's environmental awareness, its effect on actual behaviour is not clear. Studies have shown that children's pro-environmental behaviours still need to be improved upon. This could be confirmed with the result of their participation in environmental movements and organisations, as before, which was found to remain at an extremely low level (Ivanova, 2019).

Furthermore, some studies equally investigated the relationship between some other factors such as Environmental Education (EE), environmental policies, and learners' pro-environmental behaviour and practices. These studies include that of Diaz et al. (2019) which reported significant relationship between impact of teaching EE and pro-environmental skills of Mexican students. Mónus (2022) also found in Hungary that, environmental policies implemented in educational institutions had some association with secondary school students' pro-environmental attitudes and behaviours.

Instilling pro-environmental behaviours and practices among primary school pupils in Nigeria is of paramount importance. As one of the most populous nations in Africa,

Nigeria faces severe environmental challenges, including deforestation, pollution, and climate change. These issues not only threaten the country's biodiversity and ecosystems but also directly impact the health, well-being, and prospects of its citizens. Encouraging pro-environmental practices in the younger generation is, therefore, a crucial step towards mitigating these challenges and promoting sustainable development.

Primary school pupils represent a significant portion of Nigeria's population and are the future custodians of the environment. By nurturing pro-environmental behaviours and practices from an early age, we can ensure that these children grow into environmentally conscious adults. Such ingrained behaviours can shape their decisions and actions throughout their lives, leading to more sustainable consumption patterns, reduced waste generation, and greater respect for the natural world. Moreover, children often bring the knowledge and attitudes acquired at school into their homes, potentially influencing the behaviours of their families and communities.

Schools serve as vital social spaces where norms and values are shaped. By promoting pro-environmental behaviours within these institutions, we can foster a culture of environmental responsibility and stewardship. This cultural shift can have a rippling effect, spreading these values throughout the wider community and society. In a country like Nigeria, where environmental challenges are pressing, such a shift could significantly contribute to the nation's environmental sustainability and resilience. Therefore, nurturing pro-environmental behaviours and practices among Nigerian primary school pupils is not only crucial for their personal development but also for the future of the country and the planet.

It is also not out of place to consider some learning theories that can be applied to this study on assessment of Nigerian primary school pupils' pro-environmental behaviours and practices. Such theories include the behaviourism theory, the cognitivism theory and the constructivism theory. While considering the behaviourism theory (National University, 2023), the study will want to focus on some observable behaviours and practices being exhibited by the pupils with the aim of positively reinforcing good environmental behaviours and subtly reprimanding bad ones. This will serve a useful purpose in the assessment of their pro-environmental behaviours and practices.

Furthermore, the cognitivism theory (Kurt, 2023) is concerned with how information is processed and emphasises the internal mental processes that occur in learning. Applying this to the study could demand exploring how the respondents' understanding of an environmental issue influences their decision for positive environmental action. Likewise, the constructivism theory (Robottom, 2015) posits that learners construct knowledge based on their experiences. Hence, its applicability to this study can be found in checking up the pupils' active engagement in an environmental activity and making them reflect on the importance of the acquired experience for better understanding of the environmental issue involved.

Assessing pro-environmental behaviour and practices among Nigerian primary school pupils holds significant value for multiple reasons. Firstly, it offers valuable insights into the effectiveness of any existing environmental education programmes within the country's educational system. By evaluating the extent to which pupils have adopted and demonstrated pro-environmental behaviours, educators and policymakers can gauge the impact and success of these initiatives.

Secondly, a comprehensive assessment of pupils' pro-environmental behaviours and practices can pinpoint specific areas where current education programmes may fall short or require enhancement. Such an analysis can identify gaps or weaknesses in the curriculum, teaching methodologies, or practical applications, enabling targeted improvements and expansions to be made. This iterative process of assessment and refinement is crucial for ensuring that environmental education remains relevant, engaging, and impactful.

Again, assessing pro-environmental behaviours and practices among primary school pupils highlights the pivotal role that educational institutions play in promoting environmental sustainability. Schools serve as critical platforms for shaping the attitudes, values, and behaviours of the younger generation. By fostering pro-environmental practices within these formative years, schools can nurture a generation of environmentally conscious citizens who will carry these principles into adulthood and contribute to the long-term preservation of Nigeria's natural resources and ecosystems.

Hence, assessing pro-environmental behaviours and practices among Nigerian primary school pupils provides invaluable feedback on the effectiveness of the environmental education interventions that have been in place over time, identifies opportunities for improvement, and underscores the vital role of schools in cultivating a sustainable future for the nation. The findings from this assessment could provide valuable insights for educators, policymakers, and stakeholders in environmental conservation, helping to shape future strategies and interventions. The recognition of this essential role engenders the focus of this study. Specifically, the study explores the following objectives:

1. Determine the level of environmental concern and pro-environmental behaviours and practices of the primary school pupils,

2. Examine the relationship between primary school pro-environmental concerns and practices.

3. Examine the relationship between primary school pupils' environmental concerns and their pro-environmental behaviours and practices

Materials and Methods

This research is a quantitative descriptive survey type, with elementary school pupils in Primary 4 to 6 in both private and public primary schools in Ogun east Senatorial District, Nigeria as the target population. Nine hundred and sixty (960) primary 4-6 pupils from Eight (8) primary schools consisting of four public and four private schools. One hundred and twenty pupils (120) were selected from each school. However, only eight hundred and thirty-two (832) of the returned questionnaires was used for the analysis.

The instrument consists of three broad sections: Section A consists of 6 items describing the personal characteristics of the pupils. Section B has 10 items on environmental concerns and section C, consists of 14 items on pro-environmental practices. To score the completed scales, the responses of 'extremely concerned' slight concerned' 'moderately concerned' and not at all were assigned 4, 3, 2, and 1, respectively. Thus, the maximum score on each item was 4, denoting extreme concern while the lowest score on each item is 1. For pro-environmental practice scale, the responses were assigned 'always' 3, 'sometimes' 2 and 'never' 1.
Frequency, percentages, means, standard deviation, t-test, one-way analysis of variance, pearson product moment correlation and regression analysis were used. A prior alpha level of .05 was used to determine statistical significance.

Results

Table 1 shows the distribution of respondents. The sample indicated that there were 56.0% male and 44.0% female. Almost half (49.9%) of the pupils were within age group of 11-12yrs, 9-10yrs (38.8%) and 7-8yrs (11.3%). The class distribution shows that 32.1% were Primary 4, Primary 5 (36.9%) while Primary 6 (31.0%).

Table 1: Percentage distribution of pupils' demographic characteristics

	F	%		F	%
School			**Gender**		
Private	352	42.3	Male	366	44.0
Public	480	57.7	Female	466	56.0
Total	832	100.0	Total	832	100.0
Age			**Class**		
7-8 years	94	11.3	Basic 4	267	32.1
9-10 years	323	38.8	Basic 5	307	36.9
11-12 years	415	49.9	Basic 6	258	31.0
Total	832	100.0	Total	832	100.0

Table 2 shows the results on pupils' environmental concerns. The mean ranged from 2.75 (SD =.828) to 3.25 (SD = .774). It can be observed that all the 11 items used to measure environmental concerns has mean score above 2.50 which is the neutral level. Thus, suggesting that the pupils were concerned about environmental problems in their community.

Table 2: Percentage response of pupils about environmental concerns

	Extremely concern	Slight concern	Moderate concern	Not at all	Mean	Std. D
Climate change	34 (4.1)	68 (8.2)	382 (45.9)	348 (41.8)	3.25	.774
Noise Pollution	70 (8.4)	70 (8.4)	454 (54.6)	238 (28.6)	3.03	.840
Water pollution	34 (4.1)	248 (29.8)	310 (37.3)	240 (28.8)	2.91	.861
Air pollution	34 (4.1)	174 (20.9)	412 (49.5)	212 (25.5)	2.96	.791
Indiscriminate dumping of refuse or solid waste	68 (8.2)	36 (4.3)	414 (49.8)	314 (37.7)	3.17	.848
Plastic waste	36 (4.3)	104 (12.5)	384 (46.2)	308 (37.0)	3.16	.802
Public urination/defection	34 (4.1)	316 (38.0)	310 (37.3)	172 (20.7)	2.75	.828
Flooding	68 (8.2)	174 (20.9)	446 (53.6)	144 (17.3)	2.80	.818
Deforestation	68	174	446	144	2.75	.828

	(8.2)	(20.9)	(53.6)	(17.3)		
Blocked drainages	68	214	412	138	3.00	.912
	(8.2)	(25.7)	(49.5)	(16.6)		
Litters Papers & Nylon	68	140	344	280	3.25	.774
	(8.2)	(16.8)	(41.3)	(33.7)		

Note: Figures in parentheses are the percentages

The item-by-item analysis revealed that respondents are more concerned about climate change, littering of papers and nylon, indiscriminate dumping of refuse or solid waste, plastic waste, noise pollution and blocked drainage. In a follow up question "Do you ever worry about how people care for the environment?" Almost two-thirds of the pupils reacted in the affirmative. This suggests that pupils are worried about environmental problems in their communities. Pupil's pro-environmental practices are presented in Table 3. The mean for this variable ranged from 2.38 (SD = .693) to 2.79 (SD =.501) indicating that the pupils' pro-environmental practice is good.

Table 3: Percentages of environmental practices among pupils

	Always	**Sometimes**	**Never**	**Mean**	**Std. D**
I try to save water at home	106	480	246	2.45	.70913
	(12.7)	(57.7)	(29.6)		
I use the public bins to dispose papers	106	178	548	2.53	.710
	(12.7)	(21.4)	65.9)		
I do things to help conserve natural environment	106	246	480	2.45	.709
	(12.7)	(29.6)	(57.7)		
I empty our waste bin when filled up	554	104	174	2.54	.706
	(66.6)	(12.5)	(20.9)		
I leave the water running while I brush my teeth	482	208	142	2.41	.764
	(57.9)	(25.0)	(17.1)		
I turn off the TV or video games when I go eat	70	172	590	2.62	.635
	(8.4)	(20.7)	(70.9)		
I turn off light when I leave my room to go eat	102	314	416	2.38	.693
	(12.3)	(37.7)	(50.0)		
I read books about environment	138	174	520	2.46	.762
	(16.6)	(20.9)	(62.5)		
I participate in cleaning activities at school	478	142	212	2.40	.763
	(57.5)	(17.1)	(25.5)		
I participate in environmental sanitation exercise at home	586	106	140	2.57	.706
	(70.4)	(12.7)	(16.8)		
I turn off the water when I brush my teeth	106	210	516	2.49	.711
	(12.7)	(25.2)	(62.0)		
I turn off lights at home when they are not being used	104	586	142	2.58	.703
	(12.5)	(70.4)	(17.1)		
I asked my family to recycle	70	176	586	2.62	.636
	(8.4	(21.2	(70.4)		

Comparison of the mean scores of environmental concern and practice showed that significant difference between male and female pupils environmental concerns. With mean scores of girls higher than boys, the results suggest that girls are more concerned about the environment. Similarly, significant difference was observed between environmental concern of private and public-school pupils, with pupils from private school showing more concern than those from public schools. However, there was no significant difference in pro-environmental practice between male and female as well as private and public schools (Table 4).

Table 4: T-tests of significance of environmental concerns and pro-environmental practice

	Concerns				Pro-environmental Practice		
Gender	N	Mean	Std. D	t	Mean	Std. D	t
Male	366	29.268	2.751	-4.951, p**.000s**	50.718	5.335	-1.727, p.085
Female	466	30.193	2.616		51.311	4.553	
School Type							
Private	352	30.452	2.525	6.193, p**.000s**	51.256	5.510	1.031, p.303
Public	480	29.298	2.746		50.900	4.434	

Table 5 shows that pupils of different age-group differ significantly in their environmental concerns. However, pupils in 7-8yrs age-group differed with both 9-10yrs and 11-12yrs in their concerns, but no significant age differences were observed in their pro-environmental practice. Pupils of different classes do not differ significantly in their environmental concerns, while they differ significantly in their pro-environmental practice.

Table 5: Comparison of environmental concerns and pro-environmental practice among age and class

		Pro-environmental Practice		Environmental Concerns	
Age	N	Mean	Std. D	Mean	Std. D
7-8 years	94	51.181	2.794	30.436	2.416
9-10 years	323	50.947	6.425	28.808	3.175
11-12 years	415	51.101	3.831	30.400	2.099
Total	832	51.050	4.918	29.786	2.713
		F (2,829) = .126, p >.882		F (2,829) = 37.288, p <.001s	
Class	N	Mean	Std. D	Mean	Std. D
Basic 4	267	51.846	4.618	29.781	2.881
Basic 5	307	50.078	5.287	29.887	2.647
Basic 6	258	51.383	4.576	29.786	2.618
Total	832	51.050	4.918	29.692	2.713
		F (2,829) = 10.315, p <.001s		F (2,829) = .338, p <>.713	

From Table 6 there was a positive correlation (r = .256, p < .01) between pupils' environmental concerns and pro-environmental practices. This implies that the more concern an individual has for and about the environment, the more likelihood for the individual to display pro-environmental practice. There was also a positive correlation between pupils' gender (r = .169, p < .001), age (r = .126, p < .001) and environmental concerns.

Table 6: Correlation between socio-demographic variables, environmental concerns, and pro-environmental practices

	1	2	3	4	5	6
1. Gender	1					
2. Age	.086*	1				
3. School type	.055	.214**	1			
4. Class	-.009	.026	.065	1		
5. Environmental Concerns	.169**	.126**	-.210**	.028	1	
6. Pro-environmental Practice	.060	.003	-.036	-.039	.256**	1

Table 7 reveals the combined relative contribution of each independent variable to pro-environmental practice. From the result shows R= .264 with adjusted R^2 =.070, F-value of 12.395 at p<0.01. This implies that the independent variables accounted for 7.0% of the variance in the criterion variable This shows the significant influence of the predictor variables on the pro-environmental practice of pupils. Environmental concern was the most potent predictor of pro-environmental practice (β = .482; t = 7.500; p < .05).

Table 7: Multiple regression analysis of demographic factors and environmental concern on pro-environmental practices of pupils

	B	Beta	t	Sig.
(Constant)	37.191		17.958	.000
Gender	.157	.016	.464	.643
Age	-.268	-.037	-1.060	.290
School type	.301	.030	.850	.396
Class	-.293	-.047	-1.408	.159
Environmental Concerns	.482	.266	7.500	.000
R= .264, R^2 = .070, $F_{(5,831)}$ =12.395 p< .000				

Discussion

This study sought to investigate environmental concerns and pro-environmental practice of primary school pupils in Primary 4 to 6. It was found that respondents' environmental concerns were moderate. Concerns such as climate change, littering of papers and nylon, indiscriminate dumping of refuse or solid waste, plastic waste, noise pollution and blocked drainage ranked high. Furthermore,

about two-thirds of the pupils answered, 'Yes' in response to the question "if they are worried about the environment".

It also examined the differences in environmental concern and practice of pupils across gender, school type, age, and grade. Significant gender and school type differences in environmental concern were found. This finding is supported by Echavarren (2023) who opined that various studies have consistently observed gender differences in pro-environmental behaviour/practice. with the female gender exhibiting a greater propensity towards pro-environmental behaviour.

There was significant difference in environmental concern across age group but not differ in pro-environmental practice. Studies have consistently revealed that when age groups differ in environmental concern, the youngest age group show greater concern and more pro-environmental practice. It was predicted that environmental concerns would be positively correlated with environmental practices. These predictions were supported for fifth grade girls, but not for any other groups. However, first graders were significantly more concerned about the environment than third or fifth graders.

It was found that environmental concern was significantly and positively correlated with pro-environmental practice. This is consistent with previous studies which have looked at environmental concern. Such studies included that of Bohlerengen and Wiium (2022) which reported a positive correlation between character, confidence, and caring, environmental concerns, environmental attitudes, behaviour, and responsibility among Norwegian youth.

The results of the multiple regression analysis revealed that pupils' environmental concern is most potent of the predictor pro-environmental practice. The finding is consistent with (Collado et al., 2017; Liu, 2021) studies that provide significant behaviour model connecting concern to pro-environmental actions.

Conclusion and Recommendations

The research underscores the importance of pro-environmental practice in environmental sustainability and sustainable development. The findings of this study indicated that pupils are concerned about the environment and that environmental concern is positively related to pro-environmental practices. It also points out that various factors such as gender, age, and class as factors influencing children's pro-environmental practices. Sequel to the findings, the following recommendations are proposed:

1. Environmental education should be integrated into the primary school curriculum to enhance pupils understanding of environmental issues and the importance of preserving the environment. Even though this has been attempted in Nigerian schools, more concerted efforts still need to be put in place.
2. Children would need more encouragement by engaging them in activities that promote pro-environmental behaviour such as recycling, waste management, energy conservation, etc.
3. Parents and community members would need to be encouraged through various environmental awareness and skill development programmes so that they can serve as model of pro-environmental behaviours to inspire their children to do the same.
4. Governments and educational institutions should consider tangible implementation of policies that can help promote pro-environmental behaviours among children.
5. Further research should be conducted to explore other factors that may influence children's pro-environmental behaviours. This could help in designing more

effective interventions to promote such behaviours.

6. The availability of sanitation facilities and waste management practices within the school premises, especially public schools would need to be evaluated, to make necessary recommendations for their improvement. By this action, a more environmentally friendly school environment will be created, and this will significantly contribute to more pro-environmental practices among the learners.
7. The exploration of the involvement of the parents, local communities, and non-governmental organisations in the promotion of pro-environmental practices among the leaners. Opportunities for collaboration between the school and neighbouring communities as well as other social groups outside the school system will equally strengthen the development of pro-environmental behaviours and practices of the pupils.

These recommendations are based on a strong conviction of the parlance which says, "the future of our planet lies in the hands of our children". So, equipping them with the knowledge and skills they need to protect it will serve a great deal in the promotion of the needed pro-environmental behaviour in them.

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ASSESSING LEVELS OF SELECTED HEAVY METAL CONTAMINATION AND ITS RELATED HEALTH RISKS IN MANGO (*MANGIFERA INDICA*) FRUITS FROM ROADSIDES IN SOUTH-EASTERN GHANA.

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Abstract

Fruits are rich in vitamins and minerals which form a vital part of the human diet. However, these fruits may contain toxic metals of varied range of concentrations. Heavy metal contamination of food crops such as mangoes (*Mangnifera indica*) threatens human health. An assessment was carried out on heavy metal contamination and the related health risks in mango fruits from South-eastern Ghana. Samples of mango fruits (n = 65) from selected market points within three days in the first weeks of July and August 2023 were measured for iron, manganese, copper, lead, chromium, nickel, and cobalt concentrations in relation to maximum allowable limits. Standard acid digestion method was employed for metal extraction for analysis using AA240FS Varian Atomic Absorption Spectrophotometer. The results showed that seven heavy metals were detected in all mango fruits collected from the streets and a market. The concentration levels of these heavy metals ranged from Fe (0.800-5.352) $mgkg^{-1}$, Mn (0.082-0.499) $mgkg^{-1}$, Cu (0.190-0.527) $mgkg^{-1}$, Pb (0.008-0.107) $mgkg^{-1}$, Cr (0.002-0.056) $mgkg^{-1}$, Ni (0.035-0.545) $mgkg^{-1}$ and Co (0.001-0.044) $mgkg^{-1}$. The measured concentrations of these heavy metals were lower than the permissible limits set by the World Health Organization (WHO) and the Food and Agricultural Organization (FAO). The hazard index (HI) range for adults (0.0345-0.5840) and children (0.1526-0.6948) did not exceed 1 and therefore poses no health and cancer risks to consumers. The mango fruits sold at the study locations were suitable for consumption. Despite these findings, the need for periodic biomonitoring of heavy metals in mango fruits sold in Ghana to safeguard their quality and public health is an imperative.

Keywords: Permissible levels, Heavy metals, Estimated Daily Intake, Hazard Index, Lifetime Cancer Risk, South eastern Ghana

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Introduction

Mango (*Mangifera indica*) is one of the food fruits preferred by many people all over the world (Rajan, 2021; Siric et al., 2022). Mango is mostly eaten as fresh fruits by many people, particularly, in India, China, Thailand, Indonesia, Mexico, South Africa, Ivory Coast, Senegal, and Ghana (Arnoldus & Clausen, 2019; Rajan, 2021). It is estimated to account for fifty percent of all fruits in the world (FAO, 2011; Okorley et al., 2014). The fruit contains vitamins, minerals, fibres and antioxidants, and macronutrients such as Iron (Fe), Potassium (K), Phosphorus (P), and Calcium (Ca) for human health, especially for people in Africa and Asia (Elbagermi et al., 2012; Edusei et al., 2022; Lebaka et al., 2021; Prasad et al., 2022; Rajan, 2021). Besides, mango production provides livelihoods to many populations and has become an export crop for many countries of which Ghana is not an exception (Arnoldus & Clausen, 2019).

In Ghana, mango production can be observed throughout the country. However, the highest production is in the Bono, Bono East, Central, Volta, Eastern, and Greater Accra Regions of Ghana (Arnoldus & Clausen, 2019). These authors report that the common mango varieties identified in Ghana are Keitt, Kent, and Palmer besides the local varieties. Keitt, a late variety, usually produced between April and July each year is most preferred by processors due to its large fruits. There is local demand for fresh fruits as well as processed products such as mango jams, dried fruits, flavours, and juice (Okorley et al., 2014). The low quantity and quality of mango fruits observed have been attributed to diseases that cause internal defects of the fruits and chemical contamination (Arnoldus & Clausen, 2019).

Uptake of heavy metals by mango fruits may occur through atmospheric deposition in soils and on the fruit surfaces during production, transportation, and marketing (Baird & Cann, 2012; Jassir *et al*., 2005; Lente *et al*., 2012). Atmospheric dust has been identified to be a major source of heavy metals contamination of fruits (Ezeilo *et al*., 2020). Heavy metals are elements with densities above 5 g/cm^3 which occur in nature (Baird & Cann, 2012). These metals are non-biodegradable either by natural processes such as oxidation, microbial action, and general food processing procedures and are poisonous at low concentrations to humans and other living organisms (Baird & Cann, 2012; Ezeilo *et al*., 2020). The main toxic heavy metals are mercury (Hg), lead (Pb), cadmium (Cd), chromium (Cr), and arsenic (As) (Baird & Cann, 2012). Heavy metals enter the environment through both natural mineral and anthropogenic sources such as from automobile exhaust, industrial discharges, sewage sludge, and mining (Qin *et al*., 2021). When bond to short chains of carbon atoms and sulphhydryl groups (SH), which are frequently found in human enzymes, this group of metals becomes extremely poisonous and dangerous in the form of their cations (Baird & Cann, 2012). These metals are members of the list of ten chemicals of major public health concern as classified by the World Health Organization (Nwuyi, 2020). However, some other elements such as copper (Cu), cobalt (Co), iron (Fe), manganese (Mn), and zinc (Zn) are essential micro-nutrients for human health. Health concerns about heavy metals arise due to their contamination in foods such as fruits and potential bioaccumulation in various organs of the human body over a long period (Ezeilo *et al*., 2020). High concentrations of heavy metals such as Cd, As, and Pb in foods is known to cause health risks (MWRWH, 2015; FAO/WHO, 2017).

Mango production in Ghana is characterized by the intensive application of chemicals, foliage and granular fertilizers, and manure as measures to protect the plant against bacterial blackspot, anthracnose, fruit flies, stone

weevils, and other pests and diseases (Arnoldus & Clausen, 2019). Arnoldus and Clausen (2019) report that most farmers apply chemicals on their trees for as long as between eleven and thirteen times each season. Intake of fruits that may be contaminated with heavy metals poses a threat to human health. Therefore, regular biomonitoring of heavy metal accumulation in these fruits is key to ensuring food quality assurance for the population (Elbagermi *et al*., 2012). The mango fruit is mostly served in Ghana at homes, hotels, fruit joints, and restaurants as fresh-cut fruits, juice, ice cream, and yogurts (Edusei *et al*., 2022). The fruit constitutes the third most preferred fresh fruit by people in Ghana after pineapple and oranges (Edusei *et al*., 2022; Broek *et al*., 2016). Routine assessment and analysis of heavy metal contents in fruits most consumed by humans is important to ensure that their concentration levels are always within the internationally recommended permissible limits and to guarantee food quality for the population. Meanwhile, studies on heavy metal contamination and the health risks associated with the consumption of mango fruits in Ghana are limited. In Ghana, most of the assessment of heavy metals contamination in food crops have been carried out on vegetables (Lente et al., 2014, 2012; Osae et al., 2023) and not fruits such as mango which is one of the preferred fruits by "consumers". Therefore, this study assesses the levels of selected trace metals and the potential health risk that could come from the daily consumption of mango fruits in Ghana. Moreover, a risk assessment was carried out to generate quantitative data on both non-carcinogenic and carcinogenic risks associated with the daily intake of selected heavy metals through the consumption of mango fruits. The outcome of this study could provide useful information to help decision-makers to institute corrective measures or more studies to reduce contamination levels to ensure the quality of mango fruits for the protection of public health and exports.

Materials and Methods

The study area

Five main communities in Southeastern Ghana were selected for this study. Four of these communities (Agomeda, Ayikuma, Dodowa, and Adenta market) are in the Greater Accra region whereas the other community (Somanya) is in the Eastern Region of Ghana (**Figure 1**). Three sites were selected from each community for sampling at various geographical coordinates as follows; Agomeda (5º58′51.8″N; 0º00′45.4″W; 5º58′36.6″N, 0º00′34.9″W and 5º58′23.3″N, 0º00′24.1″W), Ayikuma (5º55′35.4″N, 0º02′44.1″W; 5º55′14.4″N, 0º02′12.2″W and 5º55′05.1″N, 0º03′17.4″W), Dodowa (5º53′14.3″N, 0º05′27.7″W; 5º52′42″N, 0º06′04″W and 5º52′18.2″N, 0º06′29.2″W), Somanya (6º04′41.9″N, 0º01′09.2″W; 6º04′37.7″N, 0º01′08.4″W and 6º04′19.5″N, 0º01′04.8″W) and Adenta market (5º42′19.3″N, 0º08′55.1″W). The study sites fall within three main mango-producing districts, (1) Yilo Krobo, (2) Lower Manya all in the Eastern region, and (3) Shai Osudoku in the Greater Accra region of Ghana. The four communities were chosen because these are commercial mango fruits vending centres, which are also the main mango production sites in the regions, where mango fruits are marketed in small baskets placed on table tops under sheds.

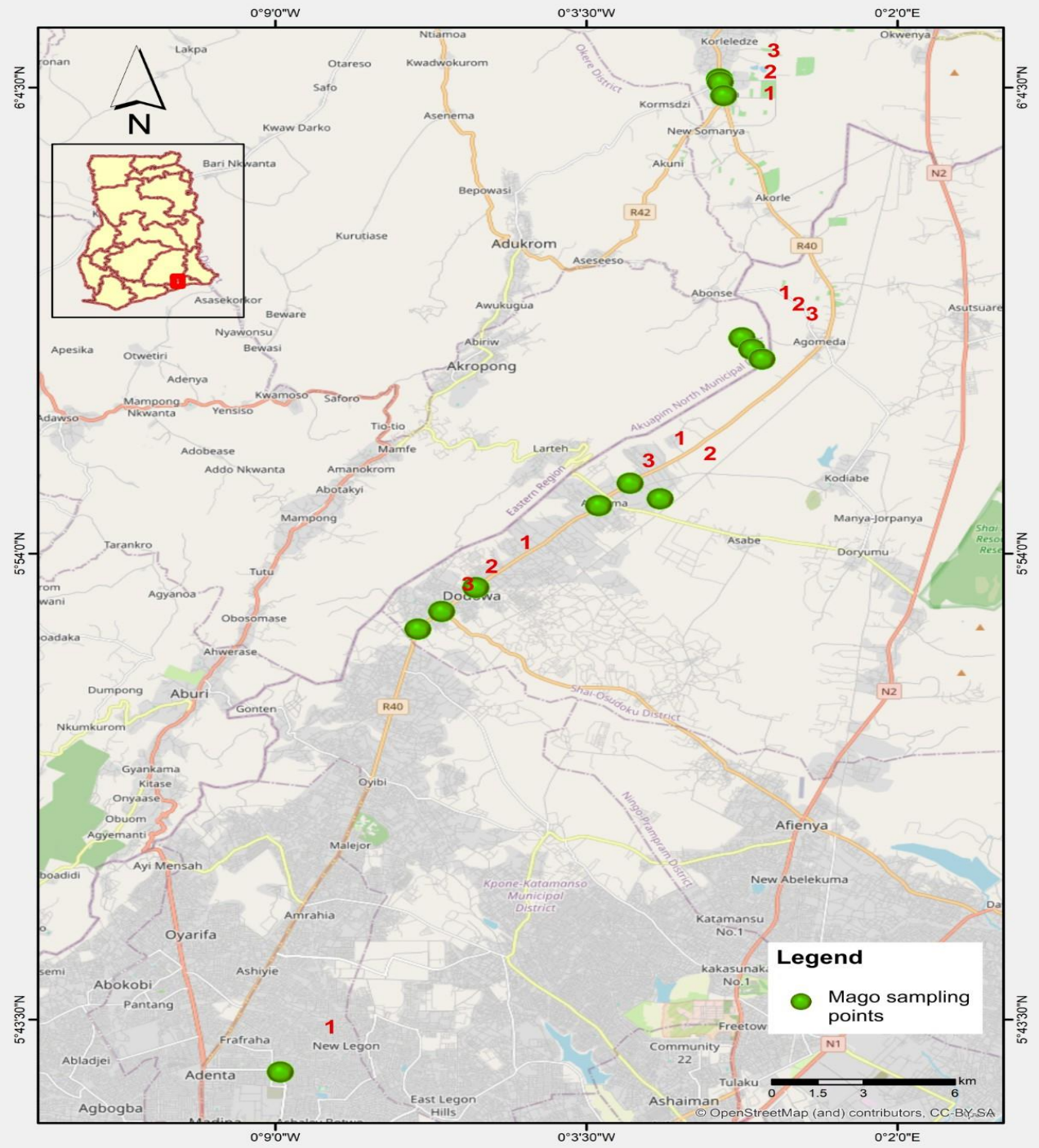

Fig. 1 A map of Southern Ghana showing locations where mango samples were taken from. This image was drawn using the ArcMap (v. 10.2.2)

Mango fruit sampling

A mixture of varieties of ready-to-eat mango (*Mangnifera indica*) fruits, including Keitt, Kent, and Palmer, which are mostly preferred by processors and consumers (Arnoldus & Clausen, 2019) were randomly sampled from each of the five study sites. A mixture of varieties was collected for analysis in order to increase the probability of sample randomization because vendors bring mango fruits from different sources. Five samples were collected from each of the thirteen sampling sites making a total of 65 samples. The samples were collected from street vendors at different locations in each community along the Accra - Somanya major road (R40) and at the Adenta market. Samples were taken during the major mango season between July and August 2023, labelled with location names and transported to the laboratory.

Laboratory analysis

The ready-to-eat mango fruit samples were first washed well with tap water followed by deionized water, sliced and placed in plastic bags. The samples were placed in a deep-freezer at -80°C and then freeze-dried for 3 days (72 hours) (Lente et al., 2012) using a Suppermodulyo Freeze Dryer at the University of Ghana Biotech Laboratory. The dried mango fruit samples were ground to powder form with a ceramic pestle and mortar. About 2.00g of powdered mango fruit sample was weighed into a 100 mL beaker and 50 mL of a ternary mixture (i.e., 500 mL HNO_3, 50 mL H_2SO_4, and 20 mL $HClO_4$) was added to each weighed sample and digested on a hot plate at a temperature of about 40°C for 30 minutes (APHA-AWWA-WEF, 2001). After the white fumes had disappeared during the digestion process, 20 mL of double deionized water was added and digested for about 10 minutes. The digestate was topped up to 50 mL with double distilled water and submitted for AAS analysis (Borowski & Schmaling, 1996). The concentration levels of each selected heavy metal including Fe, Mn, Cu, Pb, Cr, Ni, and Co were determined using the atomic absorption spectrophotometer (Model AA240FS, Varian Fast Sequential) at the Chemistry laboratories of the Ghana Atomic Energy Commission (G.A.E.C), Kwabenya-Accra, Ghana. The wavelength (nm) and the lamp current (mA) of the analytical instrument for each element were Fe (248.3 and 5), Mn (279.5 and 5), Cu (324.8 and 4), Pb (283.3 and 5), Cr (357.9 and 7), Ni (232.0 and 4), and Co (178.9 and 7).

Health risk assessment: estimation of daily intake (EDI) of heavy metals through eating mango fruits

In this study, the potential human health risk posed by heavy metals from the intake of mango fruits is assessed by comparing the measured concentration levels with the Reference doses (RfD) provided by FAO/WHO and the USEPA for fruits ingestion by humans. The EDI of selected heavy metals was calculated using mean concentrations in the mango samples and the average daily consumption of mango fruits for Ghana (FAO, 2023). The EDI of each analyzed heavy metal is estimated according to the equation (1) below and as used by the authors, Ain et al. (2023), Antoine et al. (2017), Lente *et al*. (2012) and Sharma and Prasad (2009).

$$EDI = \frac{C * Cf * IR * Ef * Ed}{BW\ X\ TAV} X\ 10^{-3} \quad (1)$$

Where EDI is the estimated daily intake of each metal in mango fruits sampled, C stands for the concentration of metal analyzed in mango fruits, Cf represents the conversion factor of fruits into dry weight (0.085) (Asharaf et al., 2021; Elbagermi et al., 2012). IR is the average fruit consumption for Ghana given by WHO/FAO (180 kg/head/year), Ef represents exposure frequency (214 days/year), Ed is the exposure duration (70

years), BW is the average human body weight (70 kg for adults and 15 kg for children) (Osae et al., 2023) and TAV represents average time of exposure [Average time (365 days/year) X number of exposure years (70)].
Equation (1) is then simplified based on the given values for the various parameters above to give equation (2). Thus, Estimated Daily intake of heavy metals (µg/kg BW/day) = Daily mango fruit ingestion (g/day) X Concentration of heavy metals (µg/g) divided by Average Body Weight (kg)

$$EDI = \frac{C * IR}{BW} \quad (2)$$

Where C (µg/kg) stands for the level of the heavy metal found in samples, EDI (µg/kg BW/day) represents the presumed daily intake of the element in mango fruits, and BW (kg) indicates the consumer's body weight (70 kg, the mean adult weight). The wet weights were converted to dry weights using the Conversion factor of 0.085 (Asharaf et al., 2021; Elbagermi et al., 2012).

Non-carcinogenic risk assessment

Non-carcinogenic risk assessment determines the likelihood that a toxicant will have a negative health impact over a period. This assessment was conducted using hazard Quotient (HQ) and Hazard Index (HI) (Lente et al., 2012; Osae et al., 2023). The HI was estimated to determine the total risk of exposure to all the heavy metals measured through ingestion of mango fruits (Lente et al., 2012; USEPA, 1997, FAO/WHO, 2010). To estimate the HI, HQ was first calculated using the equation (3).

$$HQ = \frac{DIR}{RfD}, \quad (3)$$

HQ is a ratio of the daily intake rate (DIR) to the reference dose (RfD) or minimal risk limit (MRL) (Lente et al., 2012).

$$HI = \sum HQ \quad (4)$$

HI is the sum of all the HQs of all the heavy metals in each mango fruit sample. A HI < 1 (or 100 %) indicates that the determined exposure is unlikely to pose potential health risks, whereas a HI > 1 shows a high probability of health risks.

Carcinogenic risk assessment

A carcinogenic risk assessment conducted to estimate the cancer risk (CR) is an indication of an incremental probability of an individual to developing cancer over a lifetime, usually 70 years due to exposure to a potential carcinogen. The lifetime cancer risk (LCR) is calculated as a function of the oral carcinogenic slope factor (CSF) and the estimated daily intake (EDI) of the potential carcinogenic element according to equation (5).

$$LCR = CSF \times EDI \quad (5)$$

The acceptable risk levels for carcinogens range from 10^{-4} to 10^{-6}. LCR greater than 1×10^{-4} indicates a potential cancer risk to humans whereas values below 1×10^{-6} show no risk, and risk falling between 1×10^{-4} and 1×10^{-6} is considered an acceptable range (Ikechukwu et al., 2019; Osae et al., 2023). In this study, the individual cancer risk assessment was conducted for Cr, Ni, and Pb using cancer slope factor values, Cr (0.04 mg/kg/day), Ni (0.00084 mg/kg/day), and Pb (0.0085 mg/kg/day) adopted from Osae et al. (2023) and USEPA (1989).

Analysis of variance

'Mean ± standard error (SE)' values were computed over replicates of variables for mango samples from each sampling location using R software version 4.1.1 (R Core Team, 2021). After that, multiple comparisons of mean ±SE values of concentration of heavy

metals in mango fruits between the various sampling locations were determined by fitting Tukey's HSD into ANOVA (analysis of variance) at $P \leq 5\%$ (Hirotsu, 2017). Tukey's HSD was not applied to the estimated indices or ratios for non-carcinogenic and carcinogenic details. However, tables were used to present these indices after obtaining them using the formulae in equations 1, 2, 3, and 4.

Results and Discussion

Incidence of heavy metals in sampled mango fruits

Table 1 shows the concentrations of selected heavy metals in mango fruit samples. This study only reports on heavy metals that were detected by the analytical instrument. There were significant differences ($p<0.05$) between mean values of heavy metal concentrations in mango fruits from the selected sampling locations. The highest levels of Fe (4.91±0), Mn (0.45±0), Ni (0.44±0), Cu (0.42±0), and Cr (0.06±0) $mgkg^{-1}$ were recorded in the samples from Adenta market, Pb (0.07±0.01) from Agomeda, and Co (0.03±0.01) $mgkg^{-1}$ from Ayikuma (**Table 1**). However, mangoes analyzed had lower levels of selected heavy metals than their respective maximum recommended limits (MRLs). The decreasing order of heavy metal concentrations in mango fruits was Fe>Mn>Ni>Cu>Pb>Cr>Co. Ezez and Belew, (2023) found lower mean levels of Fe (1.312±0.033 $mgkg^{-1}$), Mn (0.178±0.031 $mgkg^{-1}$), and Cu (0.127±0.007 $mgkg^{-1}$) but similar levels for Pb (0.067±0.009 $mgkg^{-1}$) in mango fruits from Southern Ethiopia compared to the levels obtained in this study. However, chromium, Cr was not detected in their study unlike the 0.06±0 $mgkg^{-1}$ detected in this study. In Uganda, Muhwezi et al. (2021) measured high mean concentration levels of Pb (0.32±0.08 $mgkg^{-1}$) and Cr (0.40±0.07 $mgkg^{-1}$) in mango fruits grown in the Kasese district. These authors observed elevated level of Pb in comparison to the MRLs by the WHO (2017). In the current study, the highest mean Pb level is 0.07±0.01, lower than the MRL standard by FAO/WHO (2011). Lente et al. (2012) attributed high Pb levels in crops to automobile emissions rather than the use of wastewater. Carcinogenic effects of lead (Pb) have been reported to include bone fractures and malfunction, cardiovascular complications, kidney dysfunction, hypertension, liver and lung diseases, nervous system disease, and immune system disease (Al-Saleh et al., 2017; El-Kady & Abdel-Wahhab, 2018; Ju et al., 2017; Krueger & Wade, 2016; Zhou et al., 2016). Siric et al. (2022) reported the concentration of Pb and Cr in mango fruits from India to be in the ranges of 0.02 - 0.15 mg/kg and 0.11 – 0.82 mg/kg, respectively, which did not exceed the safe limits. In comparison to this study, Rahim et al. (2020) measured higher concentration levels of Cr (0.081 mg/kg), Co (0.048 mg/kg), Ni (0.061 mg/kg), and Pb (0.091 mg/kg) mango fruits in Malaysia. Bioaccumulation of heavy metals may occur due to consumption of fruits contaminated with the observed metals, hence there is the need for routine testing and monitoring of heavy metals contamination in mango fruits to safeguard food quality and public health.

Table 1. Mean± standard error of concentration of selected heavy metal (mg kg^{-1} dry weight) of mango fruit (n = 65).

Selected locations (or mango market)	GPS Coordinates		Selected heavy metals in mango fruits (mg kg^{-1} dry weight)						
	Latitude (N)	Longitude (W)	Fe	Mn	Cu	Pb	Cr	Ni	Co
Adenta	5º42′19.3″	0º08′55.1″	4.91 ±0 a	0.45 ±0 *c*	0.42 ±0 *e*	0.06 ±0 *gh*	0.06 ±0 *i*	0.44 ±0 12 *k*	0.01 ±0 *l*
Agomeda	5º58′36.6″	0º00′34.9″	4.11 ±0.62 *a*	0.31 ±0.07 *cd*	0.42 ±0.06 *e*	0.07 ±0.01 *g*	0.05 ±0 *i*	0.30 ±0.12 *k*	0.00 ±0 *l*
Ayikuma	5º55′14.4″	0º02′12.2″	4.09 ±0.36 *a*	0.36 ±0.07 *cd*	0.36 ±0.02 *ef*	0.06 ±0.02 *gh*	0.03 ±0.01 *ij*	0.16 ±0.12 *k*	0.03 ±0.01 *lm*
Dodowa	5º52′42″	0º06′04″	2.32 ±0.26 *ab*	0.13 ±0.04 *d*	0.24 ±0.01 *f*	0.02 ±0.01 *h*	0.01 ±0 *j*	0.20 ±0.12 *k*	0.01 ±0 *l*
Somanya	6º04′37.7″	0º01′08.4″	1.98 ±0.82 *b*	0.14 ±0.02 *d*	0.24 ±0.02 *f*	0.01 ±0 *h*	0.01 ±0 *j*	0.21 ±0.07 *k*	0.01 ±0.01 *l*
MRL (mg/kg dry weight)			42.5	10	40	0.3	2.3	10	10

According to the ANOVA model fitted into Tukey's HSD model at $P < 0.05$, different italicized letters denote that there is a significant difference between mean values in the same column. MRL = maximum recommended limit (MRL); Values of maximum recommended limits (***MRL***) were by Tech Rep/WHO. (1993, 1989), FAO/WHO (2011) and USEPA IRIS (2011). Conversion of original wet weight values to dry weight done using a conversion factor of 0.085 (Asharaf et al., 2021; Elbagermi et al., 2012).

Health risk assessment: estimation of daily intake of heavy metals

The toxicity of heavy metals to human beings through the consumption of mango fruits will depend on factors such as consumer's age, weight, intake amount, and intake frequency (**Table 2**). Toxicity does not only depend on the concentration levels of the individual toxic metals but also the cumulative effects of all detected trace metals in the samples. Mango fruit consumption data was based on the Food and Agricultural Organization's (FAO) average fruit consumption per capita for Ghana (FAO, 2023) and the estimated number of days for which individuals consume mangoes in the study area as well as data from previous studies (Arora et al., 2008; Ashraf et al., 2021; Atta et al., 2023; Galal et al., 2021). Mango is a seasonal fruit in Ghana, which is normally eaten for about seven months in a year. It is produced in two seasons in South eastern Ghana; the major season occurs between April and August every year, whereas the minor season is between October and November annually (Arnoldus & Clausen, 2019). Hence, the estimated total number of exposure duration for the (**Table 2**).

consumption of mango in the study area is 214 days/year. According to FAO/WHO (2023), the average fruit consumption per capita in Ghana is 180 kg/head/year. Therefore, the average ingestion rate (IR) of mango fruits is calculated as 0.0715 kg/person/day. Since the estimations of risks are done on the wet weight of a consumer, a conversion factor of 0.085 is applied to transform them into dry weights as in the studies of these authors (Arora et al., 2008; Ashraf et al., 2021; Atta et al., 2023; Galal et al., 2021). **Table 2** shows the calculated metal consumption levels in mango fruit samples. The EDI values in this study were in decreasing order of Fe>Cu>Co>Pb>Mn>Ni>Cr for Adults and Fe>Co>Mn>Ni>Cu>Cr>Pb for Children (**Table 2**). In a similar study carried out in Southern Ethiopia, Ezez & Belew (2023) found EDI values in order of Fe>Zn>Mn>Cu>Cd>Pb in mango samples. The estimated (EDI) values were compared with the oral reference dose (RfD) values from the USEPA IRIS (2011) and WHO/FAO (2011). All of the metal consumption levels found in this investigation fell below the crucial oral reference value (**Table 2**).

Table 2. Estimated daily intake of heavy metals from the consumption of mango fruits from South eastern Ghana for adults and children.

	Estimated daily intake (mg/kg/day)													
	Fe		Mn		Cu		Pb		Cr		Ni		Co	
Town	Adults	Children	Adults	Children	Adults	Children	Adults	Children	Adults	Children	Adults	Children	Adults	Children
Adenta	0.00508	0.0234	0.000459	0.00215	0.000429	0.00200	$6.13x10^{-5}$	0.000286	$6.13x10^{-5}$	0.000286	0.00049	0.00209	$1.02x10^{-5}$	$4.77x10^{-5}$
Agomeda	0.00419	0.0196	0.000317	0.00148	0.000429	0.00200	0.000715	0.000334	$5.11x10^{-5}$	0.000238	0.00030	0.00143	0.00102	0.00477
Ayikuma	0.00418	0.0195	0.000368	0.00172	0.00368	0.00172	$6.13x10^{-5}$	0.000286	$3.06x10^{-5}$	0.00143	0.00016	0.00076	$3.06x10^{-5}$	0.000143
Dodowa	0.00237	0.0111	0.000133	0.00061	0.000245	0.00114	$2.04x10^{-5}$	$9.53x10^{-5}$	$1.02x10^{-5}$	$4.77x10^{-5}$	0.00020	0.00095	$1.02x10^{-5}$	$4.77x10^{-5}$
Somanya	0.00202	0.00944	0.000143	0.00067	0.000245	0.00114	$1.02x10^{-5}$	$4.77x10^{-5}$	$1.02x10^{-5}$	$4.77x10^{-5}$	0.00021	0.00100	$1.02x10^{-5}$	$4.77x10^{-5}$
RfD	0.700[a,b,c]		0.014[a,b,c]		0.040[a,b,c]		0.004[a,c]		1.500[a,c]		0.020[a,c]		0.043[a,c]	

RfD values were from (a) USEPA IRIS. (2011); (b) WHO/FAO. (2011); (c) Ashraf et al. (2021).

Health risks or hazards

Human health risk assessment is the process used to examine toxicological and epidemiological data for suspected toxicants (Hughes, 2005) such as lead, cadmium, mercury, Arsenic, and chromium in order to estimate permissible exposures (Tongprung *et al*., 2024). Therefore, in human risk assessment associated with toxic metal contamination of food crops, the hazard quotient (HQ) and hazard index (HI) are confirmatory indication of whether consumption of such food crops over time poses human health risk or not. In this study, the health risk assessment predicted the extent of toxicity or risk associated with the daily consumption of mango fruits in Ghana. This involved four mean processes; (1) toxicant identification, (2) toxicant evaluation, (3) exposure evaluation, and (4) risk estimation (Hughes, 2005; Tongprung *et al*., 2024). Toxicant identification involves a review of existing literature to identify toxic elements and their adverse effects on human health. Toxicant evaluation entails the determination of toxicants, in this case, selected toxic heavy metals in mango fruits through laboratory analysis. Exposure evaluation examines exposure parameters such as maximum daily dose to determine potential health risks. Risk estimation establishes the relation between the risk on one side and toxicity and exposure on the other side. The fourth step involves estimating the daily intake of the toxicant and the hazard quotient. Hazard quotients of estimated daily intake values are compared to established reference doses (RfD) to predict the potential health risks associated with the consumption of toxicants in the case of non-carcinogens. In risk characterization of carcinogens, the risk is a function of the carcinogenic potency slope (CPS) or the cancer slope factor (CSF) and the chronic daily intake (CDI) of the toxicant (Tongprung *et al*., 2024; USEPA IRIS, 2011; Wongsasuluk *et al*., 2014).

The hazard quotient (HQ) was calculated to assess the potential health risk associated with the daily intake of mango fruits (**Table 3**). The cumulative health risks linked to each of the chosen heavy metals in the mango fruit sample are evaluated using the hazard index (HI) (Lente et al., 2012; Muhwezi et al., 2021; Osae et al., 2023). This index represents the combined risk associated with the consumption of mango fruit samples in terms of all the heavy metals detected and is calculated by adding up the hazard quotients (HQ) for each heavy metal analyzed. When the HI value is less than 1 (100 %), the predicted exposure to heavy metals will not pose any potential health risk, but when the HI is greater than 1, it indicates a high probability of health risk to consumers (Lente et al., 2012; Siric et al., 2022). The calculated HI from this study did not exceed 1 (**Table 3**). The decreasing order of HI Values for adults was Adenta (0.5840) > Agomeda (0.2571) > Ayikuma (0.1485) > Somanya (0.0877) > Dodowa (0.0345) whereas that for children was Ayikuma (0.6948) > Agomeda (0.4498) > Adenta (0.4141) >Dodowa (0.1612) > Somanya (0.1526). The highest values for both adults (0.5840) and children (0.6948) groups were obtained from the Adenta and Ayikuma sites, respectively (**Table 3**). The highest HI values for each group of humans from Adenta and Ayikuma are relatively high since the values are more than 0.5 (50%) (**Table 3**). The Adenta sampling site is located in an enclosed market surrounded by a commercial car park, a commercial bank, a police station, and a clinic. A relatively high HI (0.5840) was recorded at the Adenta market but the highest HI (0.6948) (**Table 3**) was observed at Ayikuma. The safest and lowest HI values for adults (0.0345) and children (0.1526) groups were from the Dodowa and Somanya sampling sites (**Table 3**).

Table 3. Hazard Quotient and Hazard Index for Adults (70 kg BW) and Children (15 kg BW).

Adult								
Town	Fe	Mn	Cu	Pb	Cr	Ni	Co	**HI**
Adenta	0.00726	0.0328	0.0107	0.0153	$4.08x10^{-5}$	0.0225	$2.37x10^{-4}$	**0.584**
Agomeda	0.00599	0.0226	0.0107	0.1788	$3.41x10^{-5}$	0.0153	0.0237	**0.2571**
Ayikuma	0.00597	0.0263	0.0920	0.0153	$2.04x10^{-5}$	0.0082	$7.12x10^{-4}$	**0.1485**
Dodowa	0.00339	0.0095	0.0061	0.0051	$6.80x10^{-6}$	0.0102	$2.37x10^{-4}$	**0.0345**
Somanya	0.00289	0.0102	0.0613	0.0023	$6.80x10^{-6}$	0.0108	$2.37x10^{-4}$	**0.0877**
Children								
Adenta	0.0334	0.1534	0.0500	0.0715	$1.91x10^{-4}$	0.1045	0.0011	**0.4141**
Agomeda	0.0280	0.1057	0.0500	0.0835	$1.59x10^{-4}$	0.0715	0.1109	**0.4498**
Ayikuma	0.0279	0.1229	0.4300	0.0715	$9.53x10^{-4}$	0.0382	0.0033	**0.6948**
Dodowa	0.0159	0.0442	0.0285	0.0238	$3.18x10^{-5}$	0.0477	0.0011	**0.1612**
Somanya	0.0135	0.0476	0.0285	0.0119	$3.18x10^{-5}$	0.0500	0.0011	**0.1526**

A study conducted by Siric et al. (2022) found the HI values of four heavy metals (Cr, As, Cd, and Pb) in two varieties of mango fruits for both children and adult groups from India to be less than 1. Similar findings were reported by Qureshi et al. (2016) in a study on wastewater-irrigated fruits and vegetables from Dubai, UAE. In Ghana, many human health risks studies have been carried out on heavy metal contamination in vegetables (Lente et al., 2012; Osae et al., 2023) but not many are on mango fruits. Even though the HI values obtained for this current study are lower than 1 and may not pose a potential threat to the health of consumers, the high values obtained from the Adenta market (0.5840) and Ayikuma (0.6948) sampling locations are of concern and must inform policy on heavy metal contamination in fruits and associated human health risks in Ghana. Regular consumption of fruits contaminated with toxic heavy metals over some time may lead to potential health problems such as cancer risk, neurological damage (e.g., cognitive impairment, memory loss, etc.), kidney damage and chronic kidney disease, reproductive issues (infertility, foetal development abnormalities), gastrointestinal (e.g., nausea, vomiting, diarrhoea, and abdominal pain) and cardiovascular disease (Khan et al., 2015; Siric et al., 2022; Zukowska & Biziuk, 2008). The World Health Organization (WHO) has linked reproduction disoders of women to their exposure to heavy metals such as lead, cadmium, and mercury (Apostoli & Catalani, 2011).

Carcinogenic health risks

The results of the lifetime cancer risk (LCR) of Cr, Ni, and Pb from mango fruits contamination are presented in **Table 4**. The LCR values of Cr, Ni, and Pb for both adults and children did not exceed the acceptable limits (LCR values $< 1 \times 10^{-4}$) (in Table **4**). The highest value of LCR was for Pb from the Agomeda sampling sites (**Table 4**) for adults whereas Cr was highest for children at the Ayikuma sites (**Table 4**). The increasing order of LCR values was Ni<Cr<Pb for adults while that for children was Cr<Pb<Ni. These results suggest that there is no cancer risk associated with the intake of mango fruits by both adults and children from the study area. Similar findings were observed by Ezez and Belew, (2023) in mango fruits from the southern region of Ethiopia. Exposure to heavy metals through the ingestion of mango fruits over an extended period may not be advisable due to the accumulation of negative effects on human health. Chromium (VI) compounds are known to cause lung cancer in humans (Baird & Cann, 2012), while in addition to lung cancer, nickel compounds and metallic nickel cause cancers of the nose, nasal cavity, and paranasal sinuses (IARC, 2012). Chromium, Cr contamination has many adverse effects on the human immune system. Lead exposure is noted for abnormalities in humans including arteriosclerosis and hypertension, thrombosis, atherosclerosis, and cardiac disease). Therefore, regular monitoring of heavy metal levels in mango fruits is needed.

Table 4. Lifetime Cancer Risk (LCR) from the consumption of mango fruits from South eastern Ghana for adults (70 kg BW) and children (15 kg BW).

	LCR (mg/kg/day)					
	Cr		Ni		Pb	
Town	Adults	Children	Adults	Children	Adults	Children
Adenta	$2.45x10^{-6}$	$1.144x10^{-5}$	$3.772x10^{-7}$	$1.756x10^{-6}$	$5.211x10^{-7}$	$2.431x10^{-6}$
Agomeda	$2.044x10^{-6}$	$9.52x10^{-6}$	$2.570x10^{-7}$	$1.201x10^{-6}$	$6.078x10^{-6}$	$2.839x10^{-6}$
Ayikuma	$1.224x10^{-6}$	$5.72x10^{-5}$	$1.369x10^{-7}$	$6.409x10^{-7}$	$5.211x10^{-7}$	$2.839x10^{-6}$
Dodowa	$4.08x10^{-7}$	$1.908x10^{-6}$	$1.714x10^{-7}$	$8.005x10^{-7}$	$1.734x10^{-7}$	$8.101x10^{-7}$
Somanya	$4.08x10^{-7}$	$1.908x10^{-6}$	$1.806x10^{-7}$	$8.4x10^{-7}$	$8.67x10^{-8}$	$4.055x10^{-7}$
CSF	**0.04**		**0.00084**		**0.0085**	

Sources of information are (a) USEPA. (1989); (b) Osae et al. (2023); CSF= Cancer slope factor, Acceptable risk range = 10^{-4} to 10^{-6}.

Implications for public health

Toxic heavy metal contamination of fruits undermines food quality, safety, and public health since they pose health risks to humans (Ashraf et al., 2021; Lente *et al*., 2012; Osae et al., 2023; Qin *et al*., 2021). In general, consumption of food crops contaminated with unacceptable concentrations of heavy metals according to previous reports has been associated with human health disorders (Kiani et al., 2021; MWRWH, 2015; WHO, 2017). Therefore, there is a need to regularly monitor levels of lead, nickel, chromium, and cadmium, among others, in fruits vended in Ghana. Previous studies have linked wastewater irrigation, fertilizer and pesticides application, and automobile emissions to toxic heavy metal deposition on food crops either grown or sold close to major roads and markets (Baird & Cann, 2012; Jassir *et al*. 2005; Lente *et al*., 2012; Qin *et al*., 2021). This study will provide useful information for public health and food safety policy development and implementation.

Conclusion

The concentration of selected heavy metals in mango fruits from South eastern Ghana (i.e., Adenta, Dodowa, Ayikuma, Agomeda, and Somanya) was determined analytically and the potential health risks associated with intake were estimated. The concentration levels of selected trace metals were compared to the safe limits given in the guidelines of WHO and FAO. Lower levels of Fe, Mn, Ni, Cu, Pb, Cr, and Co that were 4.91±0, 0.45±0, 0.44±0, 0.42±0, 0.07±0.01, 0.06±0 and 0.03±0.01 $mgkg^{-1}$, respectively were measured. There were significant differences ($p<0.05$) between mean values of heavy metal concentration in mango fruits from the selected sample locations. The health risk assessment showed that mango fruits sold at the study locations were fit for consumption and did not pose any potential health risk to consumers as well as cancer risk due to elevated levels of Cr, Ni, and Pb. The risk assessment indicated that both non-carcinogenic and carcinogenic health risks may not be higher for adults and children. Even though both the concentrations of the selected heavy metals in the mango samples and their hazard indices showed no potential human health risks, it is important that regular monitoring of heavy metals in mango fruits sold along busy roadsides is carried out since vehicular emissions are a major source of toxic heavy metals to the atmosphere and

street foods. Such routine assessment also assures the consumer of the quality of the mango fruits by the roadside which will in turn boost the business and income of the mango fruit vendors.

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Declaration

Conflict of interest: The author declares that there is not any conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/ or falsification, double publication and/or submission, and redundancy has been completely observed by the author.

Life science reporting: No life science threat was practiced in this research

Author's contributions: **IL** conceived and designed the research, collected, analyzed and interpreted the data and discussed findings.

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SOCIETAL INFLUENCE ON THE DESIRE FOR LARGER BODY SIZE IN A LOW INCOME COMMUNITY, ACCRA, GHANA

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Abstract

This study examines community perceptions of ideal body size and the underlying reasons in urban poor communities in Accra, Ghana. Using a qualitative research design, data were collected through eight focus group discussions and fourteen individual interviews with community members. The findings reveal that larger body size is highly valued within these communities, with women expected to have fuller figures, while men are expected to exhibit muscularity. To achieve the desired body size, particularly among women, the use of non-prescribed medications to gain weight was common. Factors that influence adherence to the community's ideal body size included the desire to attract sexual partners, avoid stigmatization, and gain peer acceptance. The study highlights how societal preferences for larger body sizes influence social acceptability and promote unhealthy weight management practices, which may contribute to the rising risk of obesity in Ghana. These findings underscore the urgent need for culturally sensitive interventions to address body image concerns and promote healthier lifestyle choices.

Keyword: Perception, Larger body size, Obesity, Community, Ghana

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Introduction

The World Health Organisation (WHO) defines obesity as excessive fat deposits that can impair health (WHO, 2024). In 2022, about 2.5 billion (43%) adults were overweight, out of these 890 million (16%) were obese (WHO, 2024). Recent evidence in Ghana indicates that half (50%) of Ghanaian women and 21 percent of men aged 20 to 49 were overweight or obese (Ghana Statistical Service et al., 2024). Obesity is a public health concern as it can increase the risk of many diseases and conditions including type 2 diabetes, heart disease, and certain cancers (WHO, 2024). Obesity is caused by biological, genetic, social, environmental, and behavioural determinants (Spinner, 2022). In urban sub-Saharan Africa, the food environment is becoming more energy-dense with a high intake of refined carbohydrates, fats, caloric sweeteners, and animal source foods. This has been accompanied by decreased physical activity levels, thus creating an imbalance of energy intake and expenditure (Popkin et al., 2012; Mayén et al., 2014). Besides, socio-cultural perceptions about body size have contributed greatly to the increasing overweight and obesity prevalence in the region (Chigbu et al., 2021).

The socio-cultural environment is a context in which body image develops and plays an important role in the perception of, feelings and attitudes about the body. The institutionalised cultural practices and internalisation of cultural norms may influence one's perception, preference for body size and behaviours toward weight management (Abdoli et al., 2024). In Africa, preference for larger body size and associated positive attributes have been well documented (Agyapong et al., 2020; Manafe et al., 2022; Naigaga et al., 2018; Chigbu et al., 2019). The preference for fatness has been linked to a presumed cultural valuation of it as a sign of fertility, good health, beauty, wealth, respect and peace of mind (Okop et al. 2016; Matoti-Mvalo and Puoane, 2011). Chigbu et al.'s (2019) study among adults in Nigeria reported that more than two-fifths (n = 6638) of respondents perceived larger body size as desirable. A study among overweight Ghanaian women showed that although being overweight was considered undesirable by most women, weight gain was admired as it was perceived as a sign of wealth and good care by a spouse (Aryeetey, 2016).

Although evidence suggests a preference for larger body size in sub-Sahara Africa recent studies have reported a shift from the larger idealised body size towards a more Western slimmer body size, particularly among the youth (Gitau et al., 2014; Mchiza et al., 2015). The changing perception has been attributed to urbanization, exposure to Western culture and acceptance of Western ideals of beauty (Amenyah & Michels, 2016). Gitau et al.'s (2014) study among South African adolescents reported that normal body size was considered the ideal due it its association with respect, happiness, and being the best. On the other hand, being obese was considered the unhappiest and worst body size. This shift in perception and preference for body size may have implications on the incidence of obesity in sub-Saharan Africa, however, there is limited evidence in this regard, particularly, in Ghana. Therefore, it is important to examine whether the preference for larger body size still exists among adults. Additionally, studies on body size perceptions have predominantly been quantitative. The present qualitative study, therefore, explored community's ideal body size and underlying reasons in an urban poor context in Accra, Ghana. Findings from the study will help formulate and develop appropriate context-related interventions useful in addressing the increasing obesity burden in Ghana.

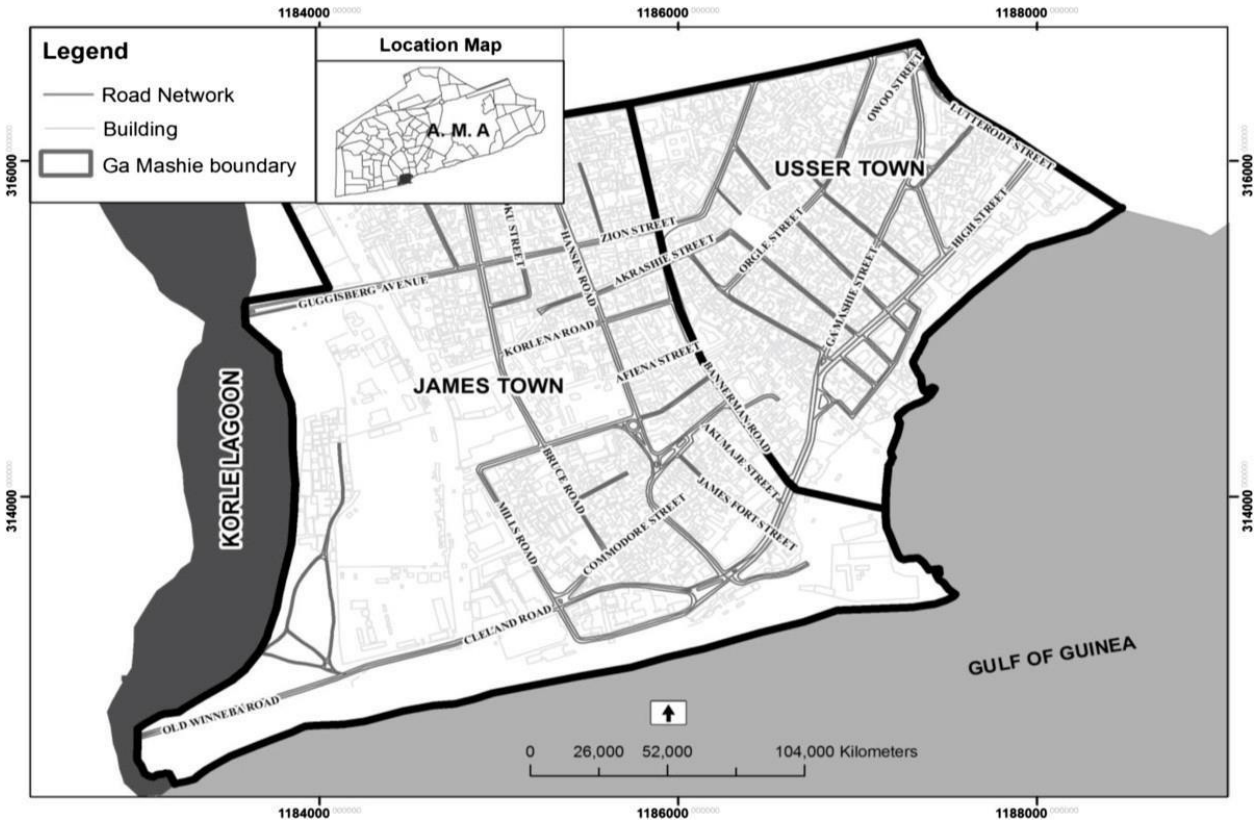

Figure 1: A map of the study area (James Town and Ussher Town)
Source: Oteng-Ababio (2014).

Materials and methods

This study was conducted in two urban poor communities in Accra - James Town and Ussher Town. These communities are spatially close to each other and are popularly referred to as Ga Mashie Traditional Area. They form part of the Ashiedu-Keteke sub-metro area in the Accra Metropolitan Area (AMA) and are predominantly of the Ga ethnic group (Ghana Statistical Service et al., 2015). Ga Mashie is located in the South of Accra, extending to the Atlantic Ocean. It is bounded in the West by a lagoon, north by an industrial area and east by a business district (See Figure 1). Fishing, fish mongering and small scale trading are the dominant economic activities of the area. Both communities are characterised by poor housing structure, sanitation and low educational status (Accra Metropolitan Assembly–UN Habitat (AMA-UN Habitat), 2011). Ga Mashie is a densely populated urban setting with a population of about 100,000. It is an indigenous and traditional community and thus, serves as an important community to examine whether or not a preference for larger body size is culturally entrenched (Mahama et al., 2011). Moreover, high levels of obesity and chronic non-communicable diseases such as hypertension and diabetes have been reported in the communities (Afrifa-Anane et al., 2015; Amon et al., 2024), and thus important to examine the community's perception and preferences about body size.

The data for this study is part of a larger research project that employed a mixed method to examine issues about body image perceptions and weight management practices (Frempong, 2017). This paper draws on individual interviews and focus group

discussions (FGDs) with community members. Fourteen individual interviews and eight FGDs were conducted. The number of interviews was determined when the saturation of views was theoretically reached. Research has established that with twelve interviews, data saturation can be achieved (Guest et al., 2006). Respondents for the individual interviews were recruited from the survey sample to obtain a homogenous sample of respondents with similar backgrounds and experiences. A convenient sampling technique was used to select respondents from the community to participate in the FGDs. Individuals aged 18 years or older who had lived in the study communities continuously for more than six months were eligible to participate. Pregnant and lactating women were excluded from the study. This is because these conditions may affect one's body weight and bias the computation of their actual body sizes.

The focus groups were segmented by age (younger adults-18-35 years; older adults 36 years and above), sex (males and females), and locality (James town and Ussher town) to ensure homogeneity in the sample and allow participants to contribute and build consensus on the issues discussed without any constraint. Both FGDs and individual interviews were conducted by the author and four trained field assistants in the local dialects (Ga and Twi). The FGDs and the individual interviews lasted about 40 minutes and 25 minutes, respectively and they were audio recorded with consent from participants. The data were collected from November, 10 to December 1, 2016.

The community's ideal body size was measured using a 'Figural Stimuli' tool developed by Pulvers et al., 2004 (see Figures 2 and 3). This is a validated figure rating scale that correlates with the standard WHO body mass index values (Underweight = BMI <18.50 kg/m^2; Normal weight (18.50 kg/m^2- 24.99 kg/m^2; Overweight (25.00 kg/m^2- 29.99 kg/m^2; Obese (≥ 30.00 kg/m^2) (WHO, 2024). Nine silhouettes present sex-specific body sizes, ranging from a BMI of 16 to 40 with constant increments of 3 kg/m^2. The Silhouettes are labelled 'A' to 'I'. 'A' represents underweight body size, 'B' and 'C' normal weight, 'D' and 'E' overweight while 'F' to 'I' represent an obese body size. The height and weight of respondents were also taken to measure BMI. Height measurements were obtained using a measuring tape (5 M/16FT measuring tape) in centimetres (cm) after the removal of slippers or shoes, and a weighing scale (Seca Scale with a maximum measurement of 150 kg) was used to take participants' weights in kilograms (kg). BMI was calculated by dividing respondents' weight (kg) by their height in meters squared (m^2) and classified according to the WHO cut-offs.

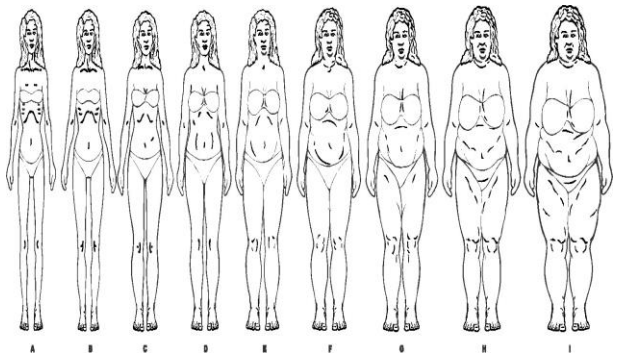

Figure 2: Females silhouette[1]

[1] Pulvers et al., 2004. Development of a culturally relevant body image instrument among urban African Americans. *Obes Res.* 2004;12:1641–1651.

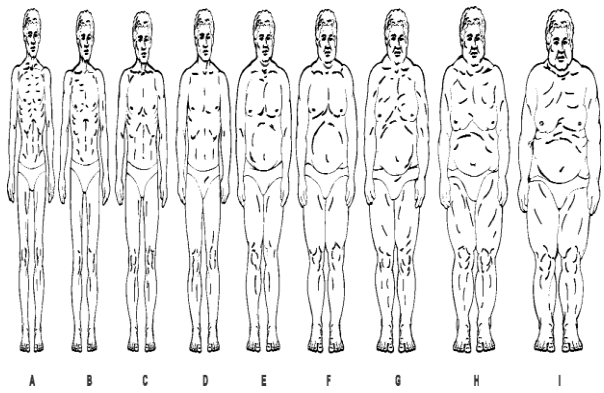

Figure 3: Male silhouettes

The audio recordings of the interviews were transcribed verbatim by two trained research assistants from the Ga and Twi languages to English. Afterward, the author and a data auditor listened to the audio files alongside the transcripts to ensure precision. To ensure anonymity, names were omitted from the audio and transcript. The transcripts were analysed in themes using Atlas ti. 7 software. The transcripts were read repeatedly for understanding and codes were developed. An initial coding framework was developed based on the interview guide and inductive codes based on emerging themes. The coding framework was reviewed by three doctoral with experience in qualitative data analysis. The revised coding framework was further reviewed by the author and the two doctoral candidates to reconcile conflicting codes.

The study protocol was approved by the institutional review board of the Ethics Committee for Humanities (ECH), University of Ghana on October 10, 2016 (ECH014/16-17). Before the data collection, the protocol was explained to each participant. They were assured that participatory was voluntary and they could withdraw from the study at any time without any consequence. They were also assured of anonymity and confidentiality regarding the information they provided.

Results and discussion

Characteristics of the participants

Table 1 shows the characteristics of the study respondents. In total, 14 individual interviews were conducted: 8 with females and 6 with males. Eight focus group discussions were conducted with an average of 5 respondents in each group, giving a total of 44 respondents. The ages of the respondents ranged from 18 to 71 years. Four out of the 14 respondents had middle or junior high school education; 5 had secondary or higher education while 2 had no formal education. The BMI status indicated that 9 respondents were overweight or obese, 4 were of normal weight and 1 person was underweight. At the group level, more than half (25) of the 44 respondents were males and half (22) were aged between 18-35. Twenty-one out respondents had attained middle or Junior High school, 14 had secondary education and a few (two) had higher education. The Body Mass Index status (BMI) of the respondents showed that half (22) of the participants had normal body size, 13 were overweight and 9 were obese. Additional characteristics of respondents are shown in Table 1.

Table 1: Characteristics of the participants

Characteristics	Focus Group Discussion (Total Number of group discussion =8). A total of 44 Participants	Individual interviews (Total Number =14)
Sex of respondents		
Males	25	6
Females	19	8
Age		
18-35	22	7
36-71	22	7
Level of education		
No education	5	2
Primary	4	3
Middle/JHS	21	4
Secondary+	14	5
Marital Status		
Single	12	3
Married	24	10
Widowed/divorce	8	1
Employment status		
Employed	29	9
Not employed	15	5
Body Mass Index (BMI)		
Underweight (<18 .5 kg/m^2)	0	1
Normal weight (18.5. to 24.9 kg/m^2)	22	4
Overweight (25 to 29.9 kg/m^2)	13	4
Obese (≥ 30kg /m^2)	9	5
Weight management Goal		
Lose weight	10	5
Gain weight	2	2
Stay about the same	32	7

Source: Field data, 2016.

Community ideal body size and underlying reasons

The findings are presented under three thematic areas: (1) *perceived community ideal body size*, (2) *Strategies to attain the ideal community body size (3) Reasons for the desire for Community ideal body size* (reasons for conformity)

Perceived community ideal body size

When asked whether there is a community perceived ideal body size, there was a consensus among the participants that yes, there is an acceptable body size in this community. They explained that the community members cherish people who are of larger body size. This perception was highlighted by the participants using the silhouette, and the choices they made ranged from card D to G as depicted in Figure 4 & 5.

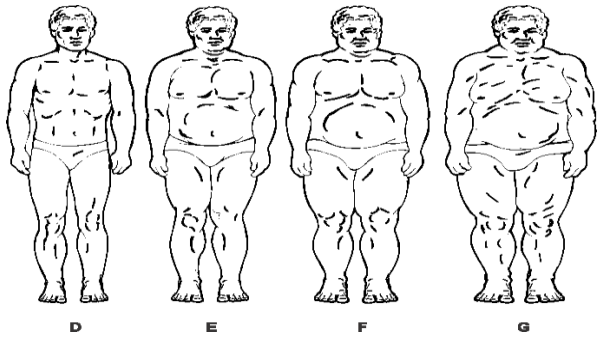

Figure 4: Male silhouettes selected by participants as the community's preferred body size.

Below are some quotes from some women to support the points:

"The preferred body size lies in-between. Many people prefer to be medium-shaped (Overweight). They do not want to be obese, and they do not want to be slim either. They want to be quite big, like this size (They pointed at Card D) (FGD 4, Younger women, James Town).

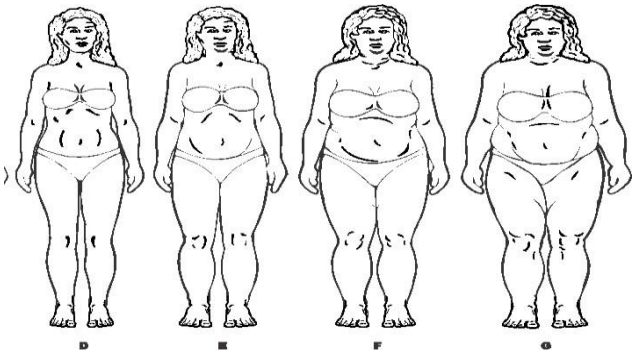

Figure 5: Female silhouettes selected by participants as the community's preferred body size.

Another participant who was obese stated: "*Here, they (community members) prefer fat people because mostly you hear from the conversation of slim people that they wish they had put on extra weight" (She selected Card F to highlight her point) (* II, obese older woman, Ussher town*).*

Additionally, there were gendered dimensions of ideal body size in the study community. Both male and female participants reported that females are expected to have bigger body sizes compared to males. Males are however expected to look muscular. Below are quotes for illustration:

"*Yes, the females are to be fat, that is, they must have enough body so that the breast and the hips must come out big and the guys must look muscular" (*FGD 6, younger men, Ussher Town*).*

*"Women are expected to weigh more than men. When a man grows bigger he is considered a fool. A man must not be too big but muscular" (*II, an obese older, James Town)

"*The women living in this community prefer a man who is tall, muscular and well-built so that when he appears everyone will catch a glimpse of him. But when you go for a man who is slim and short, the women will take you for a ride (*II, Obese older woman, Ussher Town*).*

Strategies to attain ideal community body size

Most participants reported that intake of medication was the main strategy adopted by most community members to gain weight. They explained that the community's preference for larger body size and expectation for females to be fat compel some females in the community to take non-prescribed medicines to enable them to conform to the standards of the community. These medications included 'Dexacortin', 'Paratin', 'blood tonics', and 'appetizers' such as, 'Apetamin blood tonic', 'Donewell blood tonic', and 'Bro O.T'. They further explained that in some instances, some of these medications are mixed and sold to individuals to stimulate hunger and longer sleeping hours, therefore, inducing weight gain. Below are quotes to support the notions:

"As for the medicines, they are not taken to lose weight. Many people want to gain weight; they apply the medicines to their buttocks, legs, face and everywhere. You will not see someone trying to lose weight. However, those who have gained weight continue to take medicines like Bro O.T and Dexacortin" (FGD 6, younger men, Ussher Town)

*"Yes, there is an ideal body size for everyone to have but the medicines they are taking are making them grow huge and fat. They are taking drugs to grow fat. That has become the order of the day" (*II, an overweight older woman, James Town*).*

The findings indicate that silhouettes D to G were selected as the ideal body sizes in the study areas. These cards represent an overweight and obese body size. Generally, females were expected to have larger body sizes with big buttocks and curvier shapes while males were expected to be muscular. Positive endorsement for larger body size has been documented to increase the odds of obesity (Chigbu et al., 2019). Therefore, the community's preference for a larger body size and the expectation of females to be fat could be a contributing factor to the high prevalence of overweight and obesity (57%) in the study area (Frempong, 2017). Social representation of body size dictates acceptable and preferred body sizes and thus significantly influences individuals' body image perceptions, preferences, and associated behaviours (Abdoli et al., 2024). In most societies in sub-Saharan Africa, larger body size is considered the traditional standard of beauty for women. As a result, there is greater satisfaction for larger body size and a belief that fatness has no association with developing health problems and chronic diseases such as hypertension, and diabetes (Tateyama et al., 2018; Niagaga et al., 2018; Manafe et al., 2022). This could partly explain the present finding of preference for larger body size. Although evidence in Western societies shows a preference for a slimmer body size (Aimé et al., 2020), there are variations within groups. Studies among Blacks and societies of low socio-economic status have reported a preference for larger body size (Swami, 2013; Spinner, 2023). Generally, individuals who perceive that their body size is accepted by others are less likely to want to modify it. Conversely, non-acceptance could lead to a feeling of dissatisfaction and this may drive individuals to engage in unhealthy weight management practices to help them meet the acceptable body size (Aimé et al., 2020). As found in the present study, individuals subscribed to the intake of non-

prescribed medications including Dexacortin' and 'Paratin' and other blood tonics to help them meet the societal standard of larger body size. The practice of self-medication using over the counter medications is a global healthcare challenge that is often motivated by societal and economic factors (Kamal et al., 2023). The use of non-prescribed medications to gain weight may not always be safe and thus their use may be detrimental to the health of individuals, particularly, when they are taken for an extended period. Public health education should focus on the dangers of non-prescribed medications. Also, safe weight management options including healthy eating and physical activity should be promoted.

Reasons for conformity

Three main sub-organizing themes emerged under this domain: to 'prevent stigmatization', 'attract sexual partners', and 'peer influence'

To prevent stigmatization

The participants reported that one of the main reasons for the desire among community members to have larger body size is to prevent stigmatization and mockery. According to them, slimness or loss of weight is mocked and socially not accepted. As a result, females mostly take non-prescribed medication to gain weight to avoid mockery or stigmatization. This notion was mainly highlighted by female participants as shown below:

*"Someone can even ask you to look at yourself to see how dry you look. When that happens, you get worried, so you end up looking for a way to also gain weight. If I have money, I have to also get one of the medicines to gain weight" (*FGD, older women, James Town).

*"Slimness is mocked. That is why they go in for the medicines and all that. Because at the end of the day, the only thing someone will tell you is to look at how you have slimmed down like fried fish. Uhmmmm and all that…like a sick person…. like a doll" (*II, underweight young woman, Ussher Town).

"Some of the women make remarks like having an affair with a slim woman is like chewing bones. Therefore, they use that to insult their fellow females. The males also do the same. Imagining a slim woman walking on the street, they can refer to her as "shaking off bones" (II, overweight young woman, Ussher Town).

Attract sexual partners

Some of the participants narrated that most females desire to have a larger body size to attract male sexual partners. They explained that there is the perception that the men in the community express love to females who have larger body sizes with big buttocks and breasts compared to those who are slim. This therefore influences females in the community to put on extra weight. The perceptions of respondents are supported by the following quotes:

"In this community, we value people who are fat and so they take in medicines to gain weight. If she does not gain weight how will a man be interested in her? If you can gain weight the men will be interested in you, love you and you will be happy in the community" (FGD2, older women, James Town).

"They (females) like to put on extra weight because they believe that is the best way to attract a man. And they believe that is what the men also like. I am not too sure about other places but this is what they believe in this community. They do that because they feel that is what the men want and if they wear an attire, it will fit them thereby exposing their hips, body, and shape. Men go after females who are big with big buttocks and hips" (FDG 4, James Town, younger men).

"The fatness we are talking about is that the men prefer females who are big with big

breasts and big buttocks. They prefer women who appear big in shape or have gained extra weight" (II, Obese older woman, Ussher Town)

Peer influence

Some participants also reported that peer influence drives most females to conform to the community's expectation to have a larger body size. That is, females who have fat friends are mostly pressured or influenced to become fat. The following excerpts attest to the notion:

"Yes, they (females) are worried. Let us say there are 3 friends and 2 of them are fat. People will make fun of her that her friends are good looking beautiful, so she should find a solution to her problem of slimness. I know a lot of people who are in such a mess. They want to do everything possible to look like their fat friends" (FGD, younger women, Ussher Town).

"It is the women who are usually worried about the fact that they are slim. The men are not worried. It is the women who go ahead to buy all sorts of drugs to gain weight so that they will also look beautiful. That may not be how God created them but because their friends are fat, they will also like to look the same" (FDG, Ussher Town. Older men).

The findings above show that one of the key reasons underlying the desire for an overweight or obese body size is to avoid being stigmatized. Stigmatization of slimness or weight loss has been reported as a major contributing factor to the increasing obesity prevalence in sub-Saharan Africa. Slimness or weight loss is mostly linked to poverty, marital abuse, and illness including HIV/AIDs and Tuberculosis (Matoti-Mvalo & Puoane, 2011; Okop et al., 2016). Therefore, most overweight or obese women are resistant to losing weight, and non-overweight/obese women are dissatisfied with their body size (Ozodiegwu et al., 2019).

Comparable to a study by Tuoyire et al., 2018 in Ghana, participants from the current study expressed that plump women, particularly those with wide hips, and big buttocks attract attention from the opposite side than those who are slim. To a larger extent, body size perceptions and preferences are affected by the desirability of an individual to the other gender (Abdoli et al., 2024). Larger body size has been associated with physical attractiveness and thus increases a female's chances of attracting a sexual partner (Chigbu et al., 2021). A qualitative research synthesis by Ozodiegwu et al., 2019 in sub-Saharan Africa reported that men perceived the ideal body size for women to be overweight or obese, and thus, females internalized these expectations and considered larger body size as part of the African cultural identity. African men's preference for women with larger body size, hips and buttocks has been linked to an evolutionary theory where women with such physiques are considered fertile (Pradeilles et al., 2022). However, a study carried out by Ahmed & Saltus (2012) among female university students in Sudan reported that fatness is considered unattractive as it reduces a woman's chances of securing a boyfriend or husband. The difference in findings may be due to disparity in the study population. Ahmed & Saltus' study was conducted among university students and thus, they may have acquired knowledge on the effect of obesity and related consequences.

Further, the findings indicated that peer influence compels females to desire a larger body size. This aligns with the tripartite model proposed by Thompson et al. (1999) which states that people are induced to attain ideals of socio-culturally adopted appearance because of social influences from family, friends, and media. The present finding that peers influence preference for larger body size contradicts previous findings among adolescents in sub-Saharan Africa which show that peer influence motivates

individuals to look slimmer or lose weight (Pradeilles et al., 2022; Ozodiegu et al., 2019). Significant others can influence one's decision about weight and strategies for weight management. For instance, family members and friends can convey messages of encouragement or criticisms about the body and provide negative or positive social support for nutrition, and physical activity that may impact weight management (Spinner, 2022).

Conclusion and recommendations

The findings from this study reveal a strong socio-cultural preference for larger body sizes, especially among women. To this effect, women in the study communities subscribed to the intake of non-prescribed medication to gain weight to be accepted by peers, avoid stigmatization, and attract sexual partners. The findings from the present study suggest that societal veneration of larger body size influences social acceptability or otherwise, and engagement in unhealthy weight management practices. This may hinder intervention strategies that are put in place to reduce the incidence of overweight and obesity in sub-Saharan Africa and thus reinforces the urgent need for culturally sensitive approaches in addressing body image concerns. Health policy makers should partner with regional and district health professionals to develop health education strategies to raise awareness of the importance of attaining healthy body weight and the dangers of being overweight or obese. Greater efforts should be made to counter the use of non-prescribed medications for weight gain. Future studies could replicate this study in other societies and diverse groups concerning socio-economic status and age. In particular, exploring in affluent societies and among adolescents will help provide comparable data. Moreover, it will be important to examine how unhealthy weight management techniques affect long term health.

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