

Nutrition and food safety knowledge, attitudes and practices of food handlers in primary schools in the Westrand district, Gauteng province, South Africa

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Abstract

Background

Malnutrition remains a global public health challenge affecting all age groups. Among school-aged learners, both overweight/obesity and undernutrition coexist, often driven by poor dietary patterns. The World Food Programme reports that school feeding programmes can improve nutrient intake. In South Africa, the National School Nutrition Programme (NSNP) provides daily meals to learners from low-income households, prepared by food handlers. Evaluating food handlers' nutrition knowledge, attitudes, and practices (KAP) is essential for improving meal quality and preventing foodborne diseases. However, while several studies have examined food safety knowledge, few have explored both nutrition and food safety KAP.

Aim

This study explored the nutrition and food safety KAP of food handlers in primary schools participating in the NSNP in the West Rand District, Gauteng Province, South Africa.

Methods

A qualitative phenomenological design was employed. Data were collected from 31 food handlers through face-to-face semi-structured interviews and observations using a checklist. Interview transcripts and observational data were analysed using content analysis to identify emerging themes.

Results

Findings indicated that, despite limited nutrition knowledge, food handlers demonstrated positive attitudes towards providing nutritious meals. Although participants exhibited adequate knowledge and positive attitudes regarding food safety, various contextual and resource-related challenges constrained the consistent implementation of safe practices.

Conclusion

Food preparation practices are influenced not only by knowledge and attitudes but also by structural and resource constraints within NSNP kitchens.

1. Introduction

Malnutrition remains a significant global public health challenge, affecting populations across all demographic and socio-economic groups. Among school-aged children, the increasing prevalence of non-communicable diseases (NCDs) associated with obesity and poor dietary habits coexists with persistent undernutrition resulting from inadequate nutrient intake. This dual burden highlights the complexity of addressing nutrition-related health issues in this population [1, 2].

The World Food Programme has reported that school feeding programmes are effective in improving learners' nutrient intake [3]. School-based interventions, particularly meal provision programmes, provide a strategic platform for addressing social determinants of health including poverty, food insecurity, and inadequate nutrition. In South African, the National School Nutrition Programme (NSNP) was introduced to provide daily meals to learners from disadvantaged backgrounds, alleviate hunger, and promote nutrition education among learners and school staff [4, 5].

The success of the NSNP depends largely on food handlers, who are responsible for meal preparation and play a critical role in ensuring food quality and safety [6, 7]. Berejena [7] reported that key area such as nutrition, health education and food preparation techniques are insufficiently addresses in the pre-service training programmes of food handlers. According to the Knowledge, Attitude and Practices (KAP) framework, knowledge of nutrition and food safety influences individuals' attitudes and behaviours when carrying out their duties such as food preparation and serving practises[8]. Adequate knowledge and positive attitudes can promote practises that improve food quality and safety, whereas limited knowledge and negative attitudes may result in unsafe and nutritionally inadequate meals [5, 8].

One of the few studies conducting in South Africa examining food handlers' nutrition knowledge found that overall nutrition knowledge was poor, however the study did not investigate the relationship between knowledge, attitudes and practices [6]. In addition to ensuring food safety, food handlers play a significant role in providing nutritionally adequate meals within the NSNP. Despite this, existing research has largely focused on food safety knowledge and practices and neglected nutrition knowledge[9, 10]. Furthermore, most studies have been quantitative in nature, assessing knowledge and practices through structured questionnaires, which may not adequately capture the contextual realities and motivations influencing food handlers' practices [11, 12].

This study was significant as it utilised a qualitative phenomenological design to provide an in-depth understanding of the nutrition and food safety KAP of food handlers working in the NSNP in Westrand. By identifying gaps in nutrition related KAP, the study highlights areas where training and guidelines can be strengthened.

2. Methods

2.1 Participants and study design

A qualitative phenomenological study was conducted among food handlers working in eight, quintile 1 – 3 public schools in the Westrand district, Gauteng province, South Africa. Purposive sampling was used

to recruit participants from these schools. All available food handlers (n = 31) were interviewed. This sample size is above the range of 9–17 interviews as recommended by Hennink and Kaiser [13] for achieving data saturation in a qualitative study. To ensure anonymity, participants were assigned coded (for example with P1FH2), where “P” indicates the school and “FH” indicates the food handler and the number (eg, “2”) represents the individual participant within that school.

2.2 Inclusion and exclusion criteria

Eligible participants were full time food handlers employed at the selected schools, aged 18 years or older. School staff not directly involved in food handling and part-time food handlers were excluded from the study.

2.2 Data collection

A semi-structured interview guide was developed and used to conduct face to face interviews. The interview guide was structured into three parts. **Section A** consisted of demographic characteristics, **Section B** consisted of questions on nutrition and food safety knowledge based on the South African Food-Based Dietary Guidelines (SAFBDG) [14] and World Health Organization Five Keys to Safer Food [15]. **Section C** was an observational checklist used to assess the food preparation practices of food handlers in their work environment. The interview guide was piloted in two schools and minor adjustments were made to improve clarity and relevance prior to the main data collection phase.

Interviews were conducted individually in English and local languages (Tswana and Tsonga) involving a total of 37 food handlers. Of these, 31 interviews were transcribed verbatim and translated into English. Although six interviews were excluded due to translation limitations, the remaining dataset was sufficient to achieve data saturation and thematic depth.

Data collection was conducted until rich data saturation was achieved. Preliminary data analysis was initiated after approximately 20 interviews, allowing for the identification of emerging codes and themes. Subsequent interviews were conducted to deepen understanding rather than generate new categories. The final interviews produced repetitive information indicating that data saturation had been reached. Consensus regarding data saturation was achieved among the research team members.

Ethical considerations

Ethical approval

was obtained from the Research Ethics Committee of the Faculty of Health Sciences of the University of Pretoria (634/2024). Permission to collect data was granted by the Gauteng Department of Education (8/4/4/1/2) and participating schools. All participants provided written informed consent prior to participating in the study.

2.3 Data analysis

The transcripts were analysed using content analysis to interpret and organise the interview data with the aid of Microsoft Word and Excel. The analysis was guided by the study objectives as recommended by Vaismoradi M et al [16]. A combination of inductive and deductive coding was used to generate initial codes and themes. Direct quotes from participants were quantified and used to support and demonstrate themes, consistent with the use of content analysis.

3. Results

3.1 Demographic characteristics of participants

A total of 31 participants were included in this analysis, as seen in the Table 1. Participants ages ranged from 22 years to 57 years, with 74% aged over 35 years. Most participants were female (74%) and 26% were male. Education levels varied, with only 39% having completed Grade 12. Higher education included certificates in Information Technology (IT), Communications and none were related to nutrition or food safety. The majority of the participants (93%) had less than six months of experience working in the NSNP. Two of the participants had previous experience in the programme and were currently in supervisory roles. Five of the participants reported previous employment in food service-related industries, such as retail bakeries.

Training experiences varied across schools. In four schools (P1, P4, P7 and P8) training was formally provided by the Department of Education. In contrast, other schools reported informal training conducted by coordinators or experienced food handlers.

Table 1
Demographic characteristics of study participants
(n = 32)

Characteristic	n	%
Age		
22–35 years	8	26%
> 35 years	23	74%
Gender		
Female	23	74%
Male	8	26%
Education Level		
Some high school education	19	61%
Grade 12	9	32%
Higher Education	3	7%
Duration working as food handler in the NSNP?		
< 6 months	29	93%
6–12 months	1	1%
> 12 months	1	1%

3.2 Identified themes and categories.

Participants' responses reflected varied levels of nutrition and food safety knowledge, attitudes and practices. Findings are presented under the three main categories: nutrition knowledge, food safety knowledge and attitudes and practices. Five themes and twelve sub-themes emerged from the data. Participant direct quotations are presented to illustrate and support the identified themes. A summary of the categories, themes, and sub-themes is provided in Table 2.

Table 2
Summary of themes and sub-themes on KAP of participants

Category	Themes	Sub-themes
Nutrition Knowledge	Understanding of Dietary Guidelines and Healthy Eating	Familiarity and interpretations of the SAFBDG food guide
		Understanding of the meaning of “healthy eating”
	Food Groups and Their Nutritional Roles	Correct identification of the food groups
		Poor understanding of the functions of the food groups
		Knowledge of fats and oils
Food Safety knowledge	Food Safety and Hygiene Practices	Knowledge on the prevention of food contamination
		Knowledge of expiry dates and stock rotation
		Knowledge of the importance of hygiene practices
Attitudes and practices	Nutrition Attitudes and Practices in Meal Preparation	Positive attitude towards nutrition and meal balance
		Perceptions and practices related to using salt, sugar and fat in food production.
	Food safety practices before, during and after food service	Inconsistent practice of food contamination
		Consistent daily cleaning practices

3.2.1 Understanding of Dietary Guidelines and Healthy Eating

Awareness of the SAFBDG food guide (a visual representation of seven food groups) was limited. More than half of the participants reported never having seen the guide, while a smaller number (10/31; 32%) had encountered it in clinics, kitchens, or schools. For instance, P1FH2 noted, *“I have seen it in the kitchen, but it is not complete,”* and P7FH4 added, *“Yes, maybe in the clinics and stuff.”* Despite limited exposure, several participants (11/31; 35%) recognised the image as representing healthy eating or a balanced diet. However, misinterpretations were also noted, as P8FH3 associated it with meal timing, stating, *“It is a food plan tabling in three categories as breakfast, lunch and supper.”*

Participants commonly described healthy eating in terms of balance and variety. The majority of the participants (20/31; 65%) demonstrated an understanding that healthy a combination of different food

groups. One participant explained that *"My plate, I expect it to at least have three items: a starch, a vegetable, and a protein. That is how I think a balanced and healthy meal should be"* (P6FH4). Similarly, P7FH1 replied, *"Okay, when you say healthy eating, I think of veggies. I think of fruits, milk, and proteins"*.

3.2.2 Food Groups and Their Nutritional Roles

Participants demonstrated varying levels of understanding regarding food groups and their nutritional functions. Fruits and vegetables were the most understood food group, with fifteen participants (47%) correctly identifying their role in providing vitamins as P5FH2 stated: *"Vegetables give us vitamins and help the body fight sickness"*. Daily intake was emphasised by many participants (19/31; 61%).. One participant, P7FH3 noted *"On a daily basis....It can be a fruit in the morning, vegetables maybe in the afternoon."*

The majority of the participants (21/31; 68%) recognised foods that are sources of protein such as milk and meat as *"body-building"* foods. One participant stated, *"The protein group does magic in growing our bodies"* (P2FH3), whereas a few participants (7/31; 23%) incorrectly associated this function with fruits and vegetables, P4FH5 remarked *"Fruits and vegetables help keep the body strong"*.

Starchy foods were correctly identified (19/31; 61%) with correct examples given such as, *"Rice, bread, flour and maize meal. We call them carbohydrates"* (P2FH4). However, there were some, misconceptions related to role of starch foods, including linking starchy foods to muscle growth. Only four participants (13%) specifically associated the starch food group with energy, with P3FH5 even referring to its role in metabolism. *"It's the group that kick-starts your metabolism and gives your body and brain energy."*

Participants showed some understanding of fats and oils but lacked depth in certain areas. Majority (28/31; 90%) recognised that too much fat is unhealthy, often emphasising the idea of using it *"sparingly."* Many (20/31; 65%) described reducing the amount they use, such as *"I put less of it when eating"* (P2FH2]) and *"You must not use a lot, just a little bit"* (P6FH1). Several participants linked high fat intake to risks like obesity and cholesterol, with one noting, *"If you eat too much fat, it can cause cholesterol and make you sick"* (P2FH4). Overall, moderation was well understood, though knowledge of different types of fats remained limited.

3.2.3 Food safety and hygiene practices

Preventing contamination emerged as a central theme, with food handlers consistently showing knowledge of practices such as washing of raw ingredients and proper knife usage. Participants emphasised the importance of washing vegetables before cooking with comments such as *"When cooking cabbage we wash it,"* (P1FH4) and *"Wash your vegetables to avoid food poison."* (P2FH4).

Knife hygiene was well understood by most participants (22/31; 71%), recognising the importance of cleaning knives between tasks to prevent cross-contamination. As one participant stated, *"Oh no, you must wash it first before using it again,"* while another explained, *"You must cut pumpkin, then wash (the knife) and then cut cabbage"* (P4FH5).

Knowledge of stock rotation and expiry date management was more limited. Ten participants (10/31; 32%) reported using first-in, first-out (FIFO) principles, but participants noted challenges such as inadequate storage. As P1FH3 explained, *"When we get new stock we place it under so we can use the old first,"* and P1FH4 added, *"We rotate the food storage and remove the old and put the new stock."* Among those who mentioned stock rotation, limited storage space was a common barrier, with one participant noting, *"We just put it where there is space"* (P2FH3).

Only a few participants (4/31; 13%) reported checking expiry dates. One noted, *"Before cooking check the expiry date"* (P8FH2). Participants checked stock on delivery and returned spoiled items, showing awareness of expiry as P8FH1 stated, *"You need to check the rotten stuff and bring it back to the supplier."* One participant admitted that sometimes expired items were only discovered before preparation. *"Sometimes we don't see until we start cooking, then we notice the date has passed"* (P3FH4).

Knowledge of personal hygiene emerged as a strong theme, with frequent mentions of handwashing, cleanliness, and appropriate appearance. Handwashing (13/31; 41%) was repeatedly stressed, as one participant noted: *"Always sanitise or wash your hands when you enter the kitchen... and continue doing that regularly"* (P6FH5). Personal appearance and uniform rules were also highlighted (13/31; 42%), including clean uniforms and avoiding jewellery, makeup, and long nails. As P3FH2 stated, *"I must not have make-up or earrings,"* while P1FH1 added, *"You must wear your uniform, wash your hands, cover your hair, no long nails, no earrings and rings."*

Kitchen cleanliness was universally emphasised (31/31; 100%), with participants describing daily sweeping, mopping, wiping surfaces, and keeping equipment clean. One explained, *"We always clean the kitchen before we start work and again before we leave"* (P3FH6), and another noted, *"We clean as we go"* (P6FH2). However, resource shortages sometimes limited thoroughness. As P8FH1 described, *"We have cleaning detergent but still we have a lot of cockroaches,"* and another added, *"Sometimes we don't have soap, we just rinse"* (P6FH2).

3.2.4 Nutrition attitudes and practices in food preparation

Participants expressed predominantly positive attitudes towards nutrition, with 84% recognising its role in disease prevention. The health benefits of fruits and vegetables was highly valued by about half of the participants (14/31; 45%), with statements such as, *"We must eat vegetables every day because they keep the body strong"* (P3FH1). However, observations indicated that these positive attitudes did not consistently translate into practice. Meals were often nutritionally unbalanced, particularly due to limited vegetable portions, largely attributed to resource constraints such as an absence of guidelines on food portions and limitations in food stock.

Although participants (61%) demonstrated awareness of the risks associated with excessive salt, sugar, and fat intake, practices were inconsistent. As P3FH2 noted, *"We must be careful with oil and salt—too much is unhealthy,"* and P6FH4 added, *"If we give them too much sugar, they become hyperactive."* The absence of standardised measuring tools resulted in reliance on estimation, with participants saying, *"I*

use my hand to put salt” (P2FH1) and “There’s no specific measurement. We rely on our taste buds” (P3FH6). Observations confirmed this as although measuring tools were available, they were rarely used at most schools (6/8; 75%), and unmarked containers were often used. As P6FH4 explained, *“We use those containers that people use to store atchaar.”* Despite positive attitudes towards limiting salt, sugar, and fat, the absence of standard measurements led to inconsistent practices.

3.2.5 Food safety practices before, during and after food service

The implementation of food safety practices was inconsistent and influenced by contextual constraints. Covering of cooked food emerged as a key practice for preventing contamination. Most participants (21/31; 68%) recognised the risks of leaving food uncovered, often mentioning flies, dust, and airborne particles. As one noted, *“There is a danger, yes, because when the food is not covered or sealed, anything in the air can fall into the food. Therefore, I believe that the food should be covered at all times”* (P6FH1). Observations supported these claims, schools showed measures to cover food once it had been cooked but variations in practice were seen. Half the schools (4/8; 50%) used individual covered containers, three (3/8; 38%) served from large, covered containers, and one school plated and served food uncovered to learners. While different approaches were used, the consistency of this practice indicates that covering food is a routinely applied measure of pest control and food safety.

Equipment shortages, particularly the lack of adequate knives, led to improvised practices such as bringing personal utensils and repeatedly washing a single knife between tasks. P6FH2 admitted, *“Currently, we don’t have enough knives in the kitchen, so we bring our own. We use different knives for different things. For example, if I bring two knives, one will be for onions and the other for cabbage”.* No colour-coded knife systems were observed.

Routine cleaning practices were reported and observed, with participants noting surface wiping, sweeping, and mopping. As one explained, *“We always clean the kitchen before we start work and again before we leave for the day”* (P3FH6). However, the effectiveness of these practices was often undermined by resource shortages. Observations confirmed regular cleaning, including wiping of surfaces, although limited supplies such as disinfectants and pest control products posed challenges. As P8FH1 admitted, *“We have cleaning detergents but still we have a lot of cockroaches.”*

Overall, although food handlers demonstrated awareness of appropriate food safety practices, implementation was shaped by resource limitations, infrastructure constraints, and workload demands.

4. Discussion

This study examined the nutrition knowledge, attitudes, and food safety practices of food handlers within the NSNP. The findings indicate that, despite limited formal nutrition training, food handlers demonstrated a positive attitude towards providing nutritious meals to learners. Furthermore, although participants exhibited adequate knowledge of key food safety principles and expressed positive

attitudes towards maintaining hygiene standards, the consistent application of these practices was constrained by contextual and resource-related challenges. These findings highlight a critical gap between knowledge, attitudes, and practice, suggesting that food handlers are not fully equipped to contribute optimally to the public health objectives of the NSNP.

Food handlers in this study demonstrated fragmented nutrition knowledge, largely derived from personal experience rather than formal training. This is consistent with the South African context, where food handlers are mostly community members, often without structured nutrition education, and rotate annually, limiting opportunities for sustained training [17].

Awareness of the SAFBDG was notably limited, with most participants reporting that they had not encountered the guidelines and demonstrating poor understanding of the functions of specific food groups. Similar findings have been reported in South African populations, where both awareness and adherence to the SAFBDG remain low and understanding of specific food group functions remained unclear [18]. Likewise, previous studies among NSNP food handlers in KwaZulu-Natal have reported inadequate nutrition knowledge [6]. This has important public health implications. Inadequate nutrition knowledge among food handlers may result in meals that do not meet the NSNP's objectives of improving micronutrient intake and addressing malnutrition among learners. The reliance on informal knowledge undermines the effectiveness of the programme and highlights a critical gap in training provision.

The lack of structured nutrition training leads to a reliance on informal knowledge which undermines the effectiveness of the NSNP. This highlights a critical gap in the programme's capacity to equip food handlers with the necessary knowledge for delivering safe and nutritious meals. These findings align with broader evidence which showed that inadequate nutrition knowledge influences food choices, portioning, and meal composition, thereby limiting the effectiveness of feeding programmes [6, 19].

Participants consistently expressed a commitment to providing balanced and nutritious meals and highlighted the importance of fruits and vegetables for learners' health. However, the translation of these positive attitudes into practice was constrained by limited resources and guidelines. For example, although vegetables were valued, portion sizes were often inadequate due to limited food availability, resulting in nutritionally unbalanced meals. Similar challenges have been reported in studies by Onyenweaku [20] and Mafunga [21] which identified stock shortages as a major barrier to effective implementation of the NSNP.

These findings suggest that positive attitudes alone are insufficient to ensure optimal nutritional outcomes. Structural constraints within the programme limit food handlers' ability to apply their knowledge and intentions effectively.

Consistent with previous research, participants demonstrated awareness of the long-term health risks associated with excessive consumption of salt, sugar, and fat [21, 22]. However, despite this awareness, practices remained inconsistent due to the absence of standardised measurement tools, leading to

variability in food preparation. Similar findings have been reported in other institutional feeding contexts, where reliance on experience rather than standardised measures affects meal quality [5, 23]. The findings reinforce existing evidence that inadequate nutrition knowledge and lack of standardisation compromise food preparation practices and nutritional outcomes [6, 24]. Without structured and continuous training, these knowledge gaps are likely to persist, limiting the NSNP's potential to influence child health and educational outcomes.

Food safety knowledge among participants was stronger than nutrition knowledge, which is consistent with previous research indicating that NSNP training programmes tend to focus on hygiene over nutrition [7, 10]. Participants demonstrated good awareness of personal hygiene practices and contamination prevention, aligning with NSNP guidelines and international standards such as those outlined by the World Health Organization [15]. These findings align with other studies showing that hygiene is often the most understood aspect of food safety among food handlers [6, 11]. Knowledge of food safety practices is essential among those involved in food preparation to prevent food contamination [12, 23, 25], however knowledge alone did not guarantee consistent practice. As noted by Berenjena [7], continuous training and supervision are necessary to reinforce correct practices and ensure their consistent application across different school settings [7].

Participants demonstrated a strong commitment to maintaining kitchen cleanliness, describing and practicing routine activities such as surface cleaning, sweeping, and mopping. This reflects a strong commitment to maintaining a safe kitchen environment and supports findings from similar qualitative studies, which highlight cleanliness as a core value among experienced food handlers [12, 25]. However, the effectiveness of these practices was frequently compromised by resource constraints. Limited access to cleaning supplies, including detergents and sanitising solutions, undermined hygiene standards. A review by Negassa [26] noted similar challenges in other low income setting, where inadequate access to cleaning supplies limits consistent implementation of safe practices [26]. These constraints compromise hygiene routines and increase the risk of food contamination, which pose a serious public health concern within school feeding programmes.

Observed food preparation practices were highly varied and often shaped by resource availability rather than established food safety standards. Challenges such as limited storage space, inconsistent access to cleaning supplies, and inadequate equipment such as knives, mirror findings from other South African studies highlighting infrastructure limitations in school feeding programmes can contribute to poor food safety practices [5, 27]. Poor stock rotation, inadequate storage, and inconsistent monitoring of expiry dates place learners at risk of food-borne illness. In low-income areas where NSNP meals may be the only meal many children receive, unsafe food handling could have serious consequences. This risk is particularly concerning in low-income communities, where NSNP meals may represent the primary source of daily nutrition for many learners [28]. These findings emphasize the importance of addressing structural and resource-related barriers alongside training interventions.

5. Limitations of the study

This study was conducted in primary schools within one township in the Westrand district, and therefore, the results cannot be generalised to other regions. However, the findings may provide transferable insights relevant to similar low-resource school feeding contexts. The use of self-reported data may have introduced social desirability bias, particularly in relation to food safety practices. Additionally, observations were conducted during specific time points, and this may not fully represent daily variability in food handling practices.

6. Conclusion and recommendations

This study demonstrates that food handlers within the NSNP exhibit positive attitude towards providing nutritious meals to learners despite of the limited nutrition knowledge. While participants showed adequate knowledge of essential food safety practises and expressed positive attitudes towards hygiene, the consistent implementation of these practices was constrained by contextual and resource-related challenges.

These findings highlight that food preparation practices are shaped not only individuals knowledge and attitudes but also by the structural realities and resource constraints of NSNP kitchens. These results emphasis the need for comprehensive and continuous training programmes that combines both nutrition education and food safety. Strengthening training to include basic nutrition principles will enhance food handlers' ability to contribute meaningfully to the nutritional adequacy and safety of school meals. These results highlight the need for comprehensive and continuous training programmes that integrate both nutrition education and food safety. Strengthening training to include fundamental nutrition principles, particularly the SAFBDG and the functional roles of food groups, would enhance food handlers' ability to provide nutritionally adequate meals.

Food safety training should be ongoing and context-specific, reinforcing good hygiene practices while addressing shared challenges experienced in resource-limited school settings. The provision of essential resources such as standardised measuring utensils, adequate storage facilities, and appropriate cleaning supplies is critical to enabling food handlers to apply their knowledge effectively. Finally, the development and implementation of clear, standardised guidelines on portion sizes and the use of salt, sugar, and fats are recommended to improve consistency and nutritional quality within the programme.

Declarations

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Declaration of conflict of interest

The authors have no conflict of interest to declare.

Ethical approval

This research adhered to the Declaration of Helsinki, ensuring that principles of autonomy, beneficence and non-maleficence, and confidentiality were upheld throughout the study process. The study participant signed the informed consent form to participate in the study. The research was approved by the Faculty of Health Sciences Research Ethics Committee at the University of Pretoria (reference number 634/2024).

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Author Contribution

NM developed the initial concept of the paper, reviewed the literature, conducted interviews, performed data analysis, and wrote the first draft of the article. NAM and JM validated the initial concept and literature sources, examined the methodology and data reporting, and edited and reviewed the final document.

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Data Availability

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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