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Review

The Relationship between Dietary Intake and Adiposity in South African Female Adolescents: A Systematic Review

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Abstract: The prevalence of obesity has increased significantly in developing nations over the past decade, particularly among adolescent girls. To assess the scale of this epidemic among female adolescents in South Africa, a systematic review was undertaken to investigate the connection between diet and obesity. Multiple databases (Google Scholar, Science Direct, Cochrane Library, PubMed, and Web of Science) were searched to identify studies investigating the associations between diet and various adiposity indices as outcomes. Of the 56 studies identified, 7 met the inclusion criteria. The age range of participants spanned from 11 to 21 years. Tabulation was used to report the data, study by study. The consumption of nutrients from animal sources exhibited a positive correlation with higher BMI-for-age Z scores ($p = 0.02$). Eating habits such as sporadic family meals ($p \leq 0.02$), irregular breakfast consumption ($p \leq 0.05$), and a high energy intake derived from fat were linked to an increased risk of adiposity. Additionally, factors such as socioeconomic status and residential location revealed associations with certain dietary intakes and adiposity. As more studies identify the causative role of diet in obesity, there is an urgent need for policy intervention and strategies to address the growing non-communicable disease burden in South Africa.

Keywords: adolescence; adiposity; diet; females; obesity; South Africa; review

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1. Introduction

Over the past four decades, there has been a significant increase in the global population suffering from overweight and obesity. The numbers have risen by over 90%, from 11 million individuals in 1975 to 124 million in 2016 [1–3]. In 2016, it was estimated that approximately 1.9 billion adults aged 18 years and older were overweight, with over 650 million of them classified as obese [4]. During the same period, the prevalence of obesity among children and adolescents rose from 4% to just over 18%, affecting more than 340 million individuals in this age group [4].

The escalating rates of obesity among infants, children, and adolescents are concerning due to their potential long-term effects on adulthood [5]. In recent years, obesity and overweight have been recognized as significant global public health issues [2]. Similarly, the noticeable increase in obesity rates among females in South Africa is a national public health concern, particularly for female adolescents who are at a higher risk [6].

While the prevalence of obesity and overweight in developing countries may not match that of developed countries [7], sub-Saharan African urban environments are experiencing alarming rises in overweight and obesity rates [5]. The levels of overweight and obesity reported in some sub-Saharan African countries are comparable to those in certain developed nations. In 2008, Sodjinou and colleagues reported that up to 50% of urban populations in Africa were either overweight or obese [8]. In 2013, Equatorial Guinea had the highest obesity prevalence (25%) among males, while Uganda had the lowest

(1.7%) [5]. Among females, South Africa had the highest prevalence (42%), while Ethiopia had the lowest (1.8%) [5]. An investigation comparing urban and rural areas in four African countries found that the prevalence was 85% among urban South Africans, 75% among urban Tanzanians, 68% among urban Nigerians, and less than 50% among peri-urban Ugandans [9].

Considering the high prevalence of obesity and overweight resulting from rapid dietary changes during adolescence, a critical period of growth and development with significant implications for adulthood, this systematic review aims to assess the existing evidence linking diet and adiposity among adolescent females in South Africa. Additionally, the review explores other factors that influence this relationship.

2. Materials and Method

Reporting for the review was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) 2020 Statement [10]. The 27-item checklist was followed to ensure that all relevant information was included in the review, and the flow diagram (Figure 1) was used to depict the flow of studies through each phase of the review process.

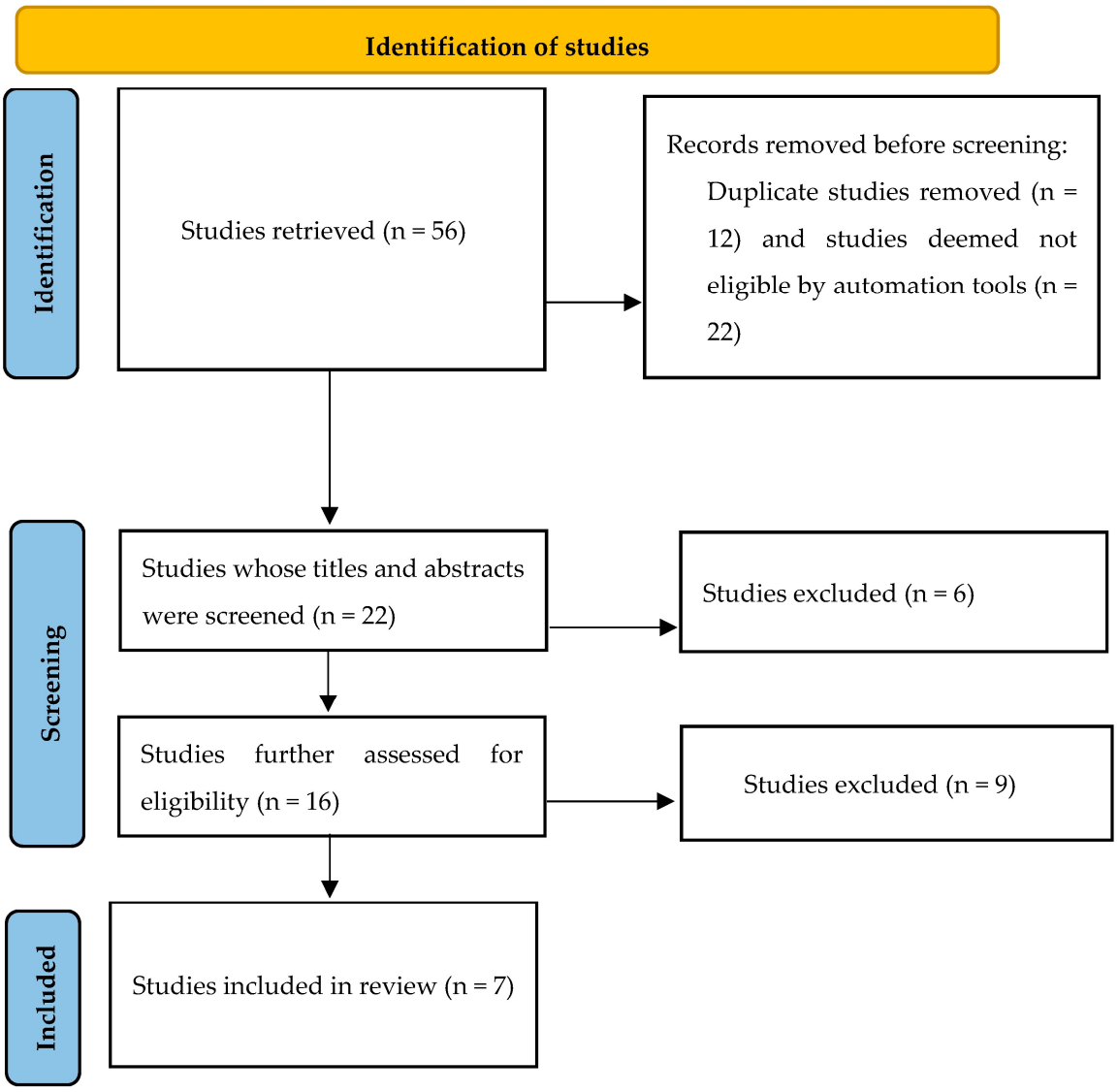

Figure 1. Systematic process and selection of publications for the current review.

2.1. Inclusion and Exclusion Criteria

We selected original articles published in English that examined the relationship between diet and adiposity in female adolescents from South Africa. The inclusion criteria encompassed articles that investigated the associations between diet (including food and nutrient intakes, dietary patterns, and practices) and various adiposity indices as outcomes. These indices included weight, Body Mass Index for age (BMI-for-age), waist circumference (WC), waist-to-hip ratio (WHR), waist-to-height ratio (WHtR), abdominal, central or visceral obesity, subcutaneous fat, skinfold thickness, body fat percentage, and lean body mass. For this review, adolescence was defined as the developmental stage between childhood and adulthood, spanning from 10 to 19 years of age [11]. We included studies of any design, provided that they reported on the association between the exposure (diet) and the outcome of interest (adiposity). Studies that involved both males and females were also considered, provided that the associations were reported separately by gender.

2.2. Search Strategy

To investigate the associations between diet and adiposity in female South African adolescents, a systematic approach was employed in this study. A comprehensive electronic literature search was conducted across multiple databases, including Google Scholar, Science Direct, the Cochrane Library, PubMed, and Web of Science. The search focused on identifying peer-reviewed articles published in English. Various search terms and phrases were utilized, such as nutrient and food intake, nutrient/food patterns, dietary practices, anthropometry, body fat, adiposity, overweight, obesity, body composition, fat deposition, body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR), waist-to-height ratio (WHtR), abdominal, central or visceral obesity, subcutaneous fat, South Africa, young women, girls, females, and adolescents. These terms and phrases were combined in different ways to retrieve relevant articles that met the predefined inclusion criteria.

2.3. Definition of Terms

1. Adiposity is an increase in body fat. This could be total body fat as indicated by BMI $\geq$ 25 kg/m^2, central fat (WHR > 0.8 or WC > 88 cm), and fat deposits and accumulation in other regions of the body [4].
2. Obesity is a state of being excessively overweight classified according to WHO Reference 2007 (5–19 years) BMI-for-age, where the +2 SD (equivalent to the 97th centile) coincides at 19 years with the adult's cut-off of BMI = 30 kg/m^2 [12].
3. Nutrient intake or dietary intake or dietary patterns are used to refer to the combinations, amounts, variety, and frequency of different foods, beverage, and nutrients habitually consumed by an individual [13].
4. Dietary practice refers to preference in food consumption or behaviours related to the ways in which individuals consume food, which can be classified as good or poor dietary practices [14].

2.4. Selection Process and Data Extraction

Based on the defined selection criteria, the reviewing team conducted a thorough search using multiple databases (including Google Scholar, Science Direct, the Cochrane Library, PubMed, and Web of Science) between November 2021 and January 2022 to identify eligible articles. To minimize the risk of bias and random error, the first stage involved three researchers searching and retrieving studies across multiple databases and 56 studies were selected (Figure 1). Duplicate studies and studies deemed not eligible after being manually screened by the three independent reviewers were removed, which left 22 studies for further screening. The remaining studies' titles and abstracts were screened, and those that appeared to meet the inclusion criteria (16 studies) were taken for a further full-text screening.

In the following stage, the full copies of the studies were carefully screened by the three researchers independently, and evaluated for inclusion. Studies were deemed eligible if they were published in English; measured the weight, BMI-for-age, WC, WHR, WHtR,

abdominal, central or visceral obesity, subcutaneous fat, skinfold thickness, body fat percentage, and lean body mass; and carried out the dietary assessment to establish the food and nutrient intakes in female adolescents (between ages 10 and 19).

Studies were deemed not eligible if (i) they were not published in English, (ii) the participants were not in the adolescent age range, (iii) the participants were not female, (iv) the study did not use any adiposity indices to measure healthy/normal weight and overweight or obese, and (v) no dietary assessment was conducted. A collaborative group discussion was then held, during which, each reviewer presented their findings for each article, and any uncertainties or discrepancies were resolved through consensus. Following the critical screening and evaluation of the 16 studies by each researcher, 7 studies were found to be eligible for inclusion.

To evaluate the quality of the studies included, each study was assessed using the Academy of Nutrition and Dietetics Evidence Analysis Manual, Quality Criteria Checklist for Review Articles [15]. The tool assesses both the validity and relevance of evidence, and the following domains were included: appropriateness of the research question; relevance of database search and the search terms; appraisal of the quality and of the studies included in the review; the process of data abstraction, synthesis, and analysis; clear presentation of results; and the consideration of biases and limitations.

Once the articles were finalized for inclusion, data extraction and validity assessments were carried out independently by the same three reviewers. Any discrepancies that arose were addressed through interactive discussions and mutual agreement. The following key data points were extracted to address the main objective of the review: author(s), publication year, sample size (pertaining to the relevant outcome), description of the participants or population, study objective, outcomes measured, observed trends, statistical significance, factors associated with dietary and nutrient practices, adiposity outcomes, and factors that were adjusted in the analyses.

2.5. Data Analysis

A descriptive narrative synthesis of the data was performed to produce results according to the outcome of interest within and between the studies that met the inclusion criteria. In addition to summarizing the textual descriptions used to explain the findings, comparison of the results between studies was conducted to explore other factors that could confound or modify the relationships between dietary intake and adiposity.

3. Results

The seven studies included in the review clearly articulated the research questions that each of the studies set out to answer. Databases in the medical and social sciences fields were searched using relevant search terms to find studies that met the inclusion criteria for the current review. A clear description of the different target populations and sample selection procedures were provided by all of the studies. The studies used either the 24-h recall questionnaire or the QFFQ to collect dietary intake. BMI-for-age, triceps skinfold thickness, and sum of skinfold thicknesses were used to measure adiposity. The dietary intake assessment methods used present a risk of bias because they do not offer an integrated assessment of nutrient status and they could present the risk of reporting error from the participants selectively reporting their dietary intake, or from not always being able to recall the quantities or all of the foods consumed. To limit heterogeneity, adjustment for potential confounding within studies was performed.

A total of 56 studies were retrieved through database searches and were reported using a PRISMA flow chart (Figure 1) [10]. The study titles and abstracts were screened, and after removing duplicates and studies deemed not eligible from the records, seven of the studies were deemed eligible for inclusion. The researchers focused on published studies; therefore, unpublished research might have been omitted during the data collection process.

Table 1 presents the seven studies that met the inclusion criteria. These studies were published between 2004 and 2021 [16–22]. The number of female adolescent participants

varied across the studies, ranging from 156 to 3490. Most of the studies focused on participants in the early adolescence stage, typically aged 11 to 15 years [16–22]. However, two studies included participants in the middle and late stages of adolescence, aged 16 to 21 years [17,18,20].

All of the seven studies [16–22] used body mass index for age (BMI-for-age) as a proxy or indicator for overweight or obesity among adolescents. In addition to BMI-for-age, the two studies conducted by Kruger and colleagues [20,22] also used triceps skinfold thickness (TSF) and sum of skinfold thicknesses (SST) to further determine overweight/obesity in adolescents.

Regarding dietary intake, four studies covered this aspect. One study employed a quantitative food frequency questionnaire (QFFQ) [17], while the remaining three studies utilized a structured 24-h recall questionnaire [21–23]. Pisa and colleagues explored the relationship between dietary patterns, sociodemographic variables, lifestyle factors, and body mass index among rural black South African adolescents [17]. In this study, Principal Component Analysis (PCA) was applied to 25 nutrients derived from quantified food frequency questionnaires (QFFQs). However, it is important to note that the use of PCA involves subjective decision-making during interpretation, name patterns, choice of variables, data transformation or standardization, number of components, and threshold for factor loadings used. Kruger conducted two studies—one investigating the causes of overweight and obesity among schoolchildren in the North West Province of South Africa, and the other examining the differences in body composition between stunted and non-stunted adolescent girls [23]. Only physical activity was found to be significantly associated with obesity in post-menarcheal girls. Napier and Oldewage-Theron investigated the dietary intake and nutritional status of adolescent girls and young women in Durban, KwaZulu Natal (KZN), South Africa [22]. The study, however, did not look at the day-to-day variations of the participant's dietary intakes.

Sedibe et al., and Feeley et al. employed interviewer-assisted questionnaires to gather information on food choices, eating practices, and dietary habits of adolescents [18,19]. Sedibe's study focused on exploring the differences and similarities in dietary habits and eating practices between younger and older, rural and urban South African adolescents [18]. The study also identified the need for further investigation of dietary practices within the home environment, which has an additional influence on the overall intake and health outcomes. Feeley examined the relationship between dietary habits, changes in socioeconomic status, and body composition among a cohort of adolescent South Africans, without examining the total energy intake of the study population [19]. Debeila, Modjadji, and Madiba utilized a food frequency questionnaire (FFQ) to investigate the prevalence of overweight/obesity and associated factors among adolescents in rural high schools [20].

Table 1. South African studies investigating the association between dietary intake and adiposity in female adolescents.

Reference	Objective of Study	Study Population	No. of Subjects	Results	Observed Trends	Statistical Significance	Factors Implicated in Dietary/ Nutrient/Practice and Adiposity Link	Factors Corrected for in the Study
Pisa, Pedro, Kahn et al., 2015 [16]	To identify and explain the association between dietary diversity and socio-demographic factors, lifestyle factors, and BMI in rural black South African adolescents.	Adolescents aged between 11 and 15 years in Agincourt sub-district of Mpumalanga Province, South Africa	n = 388	A positive and significant association was observed between BMI-for-age and animal driven nutrients, characterized by high positive loadings of nutrients from animal derived sources. No significant associations were observed between BMI-for-age Z scores and vitamins, fibre, vegetable oil nutrients, and plant derived nutrients.	Single mothers of adolescents, aged between 35 and 49 years were positively and significantly associated with a high intake of animal driven nutrients, while being in the lowest SES status tercile was negatively associated with the intake of animal driven nutrients.	$p \leq 0.05$	High animal driven nutrients were associated with increase in BMI for age Z scores.	Physical activity; educational level of mother.
Sedibe, Pisa, Feeley et al., 2018 [17]	To examine the existence of differences and/or similarities in the dietary practices of rural and urban adolescents in specific environments and their links with overweight and obesity.	The rural population was taken from Agincourt, a sub-district of Bushbuckridge, in the Mpumalanga province and the urban adolescent population was from Soweto, in Johannesburg, South African.	n = 3490	Being from a rural setting was associated with a reduction in the risk of overweight and obesity among early-adolescents, while eating the main meal with family some days, and almost every day, and an irregular breakfast consumption on weekdays; were associated with increased risk of being overweight and obese. Irregular breakfast consumption on weekends among mid-adolescents was associated with an increased risk of being overweight and obese.	An increase in the frequency of irregular breakfast consumption during the week and weekends and eating the main meal with family "some days" and "almost every day", was associated with an increases risk of overweight and obesity	$p \leq 0.05$	Breakfast, main meal with/without family, urban setting	Gender
Feeley, Musenge, Pettifor et al., 2012 [18]	To assess the relationship between dietary habits, change in socio-economic status and obesity (BMI and fat mass) in adolescents.	Black participants aged 13, 15, and 17 years participating in the Birth to Twenty (Bt20) study, living in Soweto-Johannesburg.	n = 1298	A positive association was found between irregular breakfast consumption on weekends and obesity.	Increase in frequency of irregular breakfast consumption on weekends was associated with an increase in obesity.	$p < 0.05$	Irregular breakfast consumption on weekends	Household assets.
Debeila, Modjadji and Madiba, 2021 [19]	To determine the prevalence of overweight/obesity and the association with selected factors amongst adolescents in rural high schools.	Adolescents from high schools at Fetakgomo Municipality in rural Limpopo Province, South Africa.	n = 378	Overweight and obesity amongst adolescent girls was associated with the number of employed adults in the household, age, and sex, while eating breakfast reduced the risk.	Being an older adolescent girl, and living in a household with employed adults was associated with overweight/obesity. The overall overweight/obesity prevalence in this study was higher than the national range of 8.6–27.0% amongst adolescents aged 15–19 years reported by the United Nations Children's Fund.	$p < 0.05$	Eating breakfast, energy-dense and nutrient-poor (mainly based on starches).	

Table 1. *Cont.*

Reference	Objective of Study	Study Population	No. of Subjects	Results	Observed Trends	Statistical Significance	Factors Implicated in Dietary/ Nutrient/Practice and Adiposity Link	Factors Corrected for in the Study
Kruger, Kruger and Macintyre, 2006 [20]	To investigate overweight status according to BMI and body fat percentage and identify the determinants of overweight and obesity among adolescent schoolchildren in a population in transition.	Schoolchildren aged 10- to 15-years in the North West Province, South Africa.	n = 1257	Prevalence was higher in female white children, in urban areas, living in smaller households, and parents with low- or high-income occupations. Inactivity and increasing age in girls were found to be influential in the development of overweight/obesity. Being a female of post-menarche age was identified as a determinant of higher body fat content	Low activity levels, living in urban areas (towns/cities or informal settlements close to towns/cities) were associated with increases in overweight or obesity. There was also an association between exposure to a Western, urbanised lifestyle and an increase in the prevalence of obesity.	$p < 0.05$	Consuming more fat for energy per day. High intake of cereal- or starch-based staple foods (maize meal, bread, rice), empty-kilojoule snack foods (cheese curls) and cold drinks, and low consumption of nutrient-dense foods (milk, meat, fruit, vegetables).	
Napier and Oldewage-Theron, 2015 [21]	To ascertain the food intake practices and nutritional status of female adolescents (14–18 year) and young women post school (19–28 years).	Adolescent girls (aged 14 to 18 years) and young women (aged 19 to 28) post-school living in informal settlements in the eThekwini municipal district, Durban, province of KwaZulu Natal.	n = 523 (adolescent girls n =156)	Of the adolescent girls, 43% were classified as possibly at risk of overweight, 12.8% were classified as overweight, and 1.9% were classified as obese. The diet consumed by the adolescents was reportedly low in dairy, fruit, and vegetables. As a result, nutrients for calcium in 27.6%, vitamin A in 70.9%, vitamin C in 46.7%, and Iron in 42.3% of the sample did not meet the Estimated Average Requirement (EA) for their age group. In addition, large number of the adolescents had inadequate intakes of energy (89,1%), and total dietary fibre (93.6%), and 25% of the adolescents had inadequate protein intake.	High consumption of the carbohydrate-rich and sugary food with a low milk, legume, vegetable, and fruit consumption.	$p < 0.05$	High carbohydrate-rich and sugary food intake, and low milk, legume, vegetable, and fruit consumption.	Age
Kruger, Margetts and Vorster, 2004 [22]	To examine if any differences in body weight, subcutaneous skinfold thicknesses, and waist circumferences (body composition) exist between stunted and non-stunted girls.	African adolescent girls, of school going age (10 to 15 years), in the North West Province, South Africa	n = 478	As a result of the high energy consumption, stunted girls had higher triceps skinfold (TSF) and subscapular skinfold thicknesses (SSF) compared to non-stunted girls. The TSF and SSF levels among the stunted adolescents were found to increase with increase in age.	At a given energy intake and level of physical activity, stunted adolescent girls were found to store more body fat than non-stunted girls, which increased for each year of ages.	$p < 0.05$	Stunted girls had a higher dietary energy and macronutrient intakes, and the percentage contribution of each macronutrient per kilogram of body weight; however, it has been proposed that stunted children have lower energy requirements and should have lower total energy intakes than non-stunted children.	Adjustments for confounding factors such as dietary intake and physical activity.

4. Discussion

This paper represents the authors' first attempt to investigate the relationship between diet and adiposity in female South African adolescents using a systematic review approach. The prevalence of obesity has been increasing globally, with developing nations experiencing an accelerated rise [24]. Gender differences in overweight and obesity prevalence have been observed in both developing and developed countries, with females generally being more at risk [25].

Extensive research has been conducted to explore the link between diet and obesity in various populations. Factors such as physical activity (PA), urbanization, and economic development (as indicated by gross domestic product (GDP)) have been associated with an increased risk of obesity [26,27]. In South Africa, two studies have demonstrated a positive association between economic growth and obesity in children and adults [28,29]. This can be attributed to the expanding economy facilitating increased availability and demand for Westernized diets, convenience foods, and sedentary lifestyles as people's incomes rise. Consequently, urban women in countries undergoing economic development have experienced significant increases in overweight and obesity, while rural women are catching up with their urban counterparts [30]. In developing nations such as South Africa and Mexico, the consumption of a high-animal protein and fat diet has been linked to obesity in adults [31]. High energy, fat, and carbohydrate intakes have also been directly associated with elevated sub-scapular skinfold measurements among children aged 2 to 15 years in South Australia [32]. Similarly, Pisa and colleagues found that high animal-driven nutrient intake was associated with an increased risk of overweight and obesity [17].

Adolescence is a critical period of human development when organs and physiological systems undergo maturation [33]. Furthermore, a significant portion of adult weight, especially in females, is attained during this stage, which is characterized by faster secondary growth velocity compared to males. The prevalence of overweight and obesity, along with associated cardiometabolic risk factors, hypertension, coronary heart disease, type 2 diabetes, stroke, and mortality in adulthood, dramatically increases during adolescence [34].

A review of data from developed and developing countries revealed that the prevalence of overweight among children and adolescents in Africa and Asia averaged below 10%, while the Americas and Europe reported a prevalence of around 20% [35]. The trend of rising overweight and obesity prevalence observed in women in developing countries is also evident in younger girls. Similarly, adolescent girls in South Africa face a significantly higher risk of being overweight and obese compared to boys [6]. In Kenya, a higher level of overweight was found among female children aged 9–11 years [36].

Several factors contribute to the increasing prevalence of overweight and obesity in developing nations, including sedentary lifestyles, adoption of Westernized diets, economic development, mechanized transportation, urbanization, and changes in dietary patterns [21,37–39]. These drivers differ from those observed in developed countries, which include factors such as meal frequency, breakfast skipping, paternal education, unemployment, and family history of arterial hypertension [40]. The development of obesity in adolescent girls is influenced by a combination of physical, biological, and developmental factors [41]. The association between diet and adiposity in South African female adolescents is influenced by factors such as socioeconomic status, living arrangements, and physical activity habits [6].

Obesity can also be caused by various factors, including molecular, genetic, developmental, behavioral, and environmental influences [42,43]. Excessive consumption of high-fat, energy-dense foods has been linked to a cycle of increased desire and consumption of such foods, leading to weight gain [44]. Some studies suggest that the quality of nutrients, rather than their quantity, plays a role in the development of obesity [45].

Mothers' primary role in creating the home food environment and serving as role models for eating behaviors has been identified as a contributor to early childhood overweight and obesity [46,47]. Additionally, lower education attainment and low socioeconomic status within families have been associated with frequent consumption of sweetened drinks, fast food, and a lower intake of fruits and vegetables [6,48,49]. Access to convenience foods,

decreased availability of physical activity opportunities during childhood and adolescence, and the use of food as a reward or for socializing contribute to the risk of obesity and overweight [50–52]. The misuse of food in these contexts promotes unhealthy relationships with food, further increasing the risk of developing obesity [43]. With BMI being reported as 25–40% heritable, obesity can also have genetic, epigenetic, metagenomic, and environmental factors [53]. Given the growing evidence of the role of diet in adiposity and cardiovascular disease risk, effective strategies, including policy support and targeted actions, are needed to prevent the escalating burden of non-communicable diseases in South Africa [53].

While the studies included in the review make an important contribution to determining the relationship between diet and adiposity in female South African adolescents, evidence from studies that have a more holistic approach, that have used a variety of study designs, and that have used different tools may be required to establish if a definitive relationship exists [54]. In addition, nationwide research is essential for providing a national perspective that considers the differences that exist in a country such as South Africa, whose population exhibits a wide range of socio-economic statuses.

Because there is no single dietary assessment method that is able to measure intake perfectly [55], the FFQ and the 24-h recall methods were used to assess usual diet in the reported studies, as they are well known and extensively used methods for providing detailed food intake data. The limitation of these assessment methods is that they do not take into consideration changes in people's food intake over days, weeks, months, and even years throughout the lifecycle [56]. Furthermore, because of self-reporting and measurement inaccuracies, these dietary intake assessment methods have inherent limitations that cannot be ignored [57]. Biochemical markers used in combination with a number of dietary intake assessment methods could be a more effective measure, as they provide greater accuracy than simply using one dietary assessment [55,57]. Another important consideration to make in the interpretation of the results is that most of the studies included in this systematic review focused on black South African adolescents; therefore, the findings cannot be generalized to other subgroups found in South Africa [16,18].

In the reported research studies, weight and height measurements were used to calculate the BMI-for-age, which was used as a proxy or indicator for overweight or obese. It is important to note that BMI disregards other contributing factors such as sex, ethnicity, muscle mass, and body fat distribution [58]. The use of dietary intake without considering physical activity as factors that contribute to the incidence of obesity is a limitation of the study. The findings from the review, however, add to the concerns regarding the high levels of obesity, which are a major burden to the South African health system [59].

To address these concerns, population-level interventions targeting the school food environment that are directed at reducing overweight and obesity rates in adolescents are recommended [60]. The school environment is the ideal setting for preventative interventions meant to reduce adolescent obesity because people in the target ages (10 to 19 years) spend a significant amount of their time in school, where they consume up to 30% of their daily calories [61]. To combat hunger among children of school-going age in the country, the Department of Basic Education has been providing one nutritious meal daily at school through the school feeding program, the National School Nutrition Programme (NSNP), since 1994 [62]. Interventions targeted at obesity could be added to run alongside the school feeding program. Efforts meant to address obesity and overweight through the schools have the ability to provide interventions that are specifically targeted to learners from different socio-economic groupings. Interventions that use the school environment also have the added advantage of access to different stakeholders, such as teachers, food vendors, the school governing body, and parents, who can be used directly or indirectly as agents of change [63].

Comprehensive family, school, and community-based intervention programs including education on diet intake and physical activity targeting adolescents should be strength-

ened. Additionally, evidence-based mobile health interventions designed to address overweight and obesity among adolescents can be beneficial [55].

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