Comparing Adolescents at Risk and Not at Risk of Non-Communicable Disease in Terms of Body Composition and Physical Activity in the Eastern Cape, South Africa

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RESEARCH

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ABSTRACT

Non-communicable diseases (NCDs) accounted for 51% of total deaths in South Africa in 2016. Adolescents demonstrating unfavorable body composition and low levels of physical activity are more susceptible to additional risk factors associated with NCDs. This study aims to compare adolescents at risk and those not at-risk regarding body composition and physical activity in the Eastern Cape, South Africa, utilizing a cross-sectional design with a stratified random sample of 257 adolescents aged 10–19 years. Participants were categorized as either "at risk" (displaying one or more metabolic risk factors) or "not at risk" (no risk factors). BMI and body fat percentage were measured, and the International Physical Activity Questionnaire (IPAQ) was employed to indirectly assess their physical activity levels. Data analysis included descriptive statistics, independent samples t-tests, Chi-square tests, and logistic regression. Among the 257 adolescents studied, 131 (50.9%) exhibited one or more metabolic risk factors. The at-risk group displayed a higher mean BMI value (25.49 ± 6.11), while higher mean body fat percentages were observed among female participants (30.80 ± 6.82). Notably, both groups met the minimum physical activity requirements recommended by the World Health Organization. Adolescents with a higher sum of skinfolds (indicative of adiposity) were found to be 1.13 times more likely to develop NCDs. These findings underscore the significance of body fat as a prominent risk factor for NCDs in adolescents. Moreover, the study suggests that physical inactivity may not be a primary risk factor for NCDs among adolescents in the Eastern Cape, South Africa.

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INTRODUCTION

Adolescence (10–19 years of age), is a critical period of transition into adulthood, exposing individuals to different unhealthy behaviors that often persist into later stages of life (Urmy et al. 2020), for example, the extensive use of technology and screens has resulted to a more sedentary lifestyle among adolescents, contributing to unhealthy behaviors and raising the risk of obesity and other health problems (Christofaro et al. 2016). Non-communicable diseases (NCDs) are medical illnesses or diseases that are defined as non-infectious and non-transmissible among people (Fuller et al. 2020). NCDs are c chronic health conditions caused by a complex interaction of genetic, physiological, environmental, and behavioural factors (WHO. 2018). Representing a substantial portion of global mortality, NCDs encompass ailments such as heart disease, stroke, cancer, diabetes, and chronic lung disease, account for 70% of total fatalities worldwide (WHO. 2019). Globally, the prevalence of four or more risk factors for NCDs among adolescents has increased from 14.8% in 2003–2007 to 44% in 2013–2017 which can be attributed to several causes, including poor diet, physical inactivity, smoking, and overweight/obesity, resulting in an estimated three-fold increase (Biswas et al. 2022). According to the World Health Organization (WHO), NCDs are expected to be the primary cause of death in Sub-Saharan Africa by 2030 (Owopetu et al. 2021). This projection predicts that NCDs will contribute to more than 70% of all fatalities in the region (Owopetu et al. 2021).

The prevalence of NCDs and related risk factors in South Africa (SA) has increased during the last two decades (Ajaero et al. 2021). The country is currently dealing with a quadruple burden of disease, signifying the convergence of four distinct epidemics affecting the population (Akseer et al. 2020; Kamkuemah et al. 2021). These encompass maternal, neonatal, and child health; HIV/AIDS and tuberculosis (TB); NCDs; and violence and injury (Akseer et al. 2020; Kamkuemah et al. 2021).

In 2016, NCDs accounted for 51% of all fatalities in South Africa (Kamkuemah et al. 2021). Specifically, heart disease exhibited a mortality rate of 100 deaths per 100,000 males and 60 deaths per 100,000 females (de Wet-Billings. 2021). While genetic factors are implicated in the pathogenesis of these diseases, lifestyle factors, including physical inactivity, also exert influence on the progression of non-communicable diseases (de Wet-Billings. 2021).

This underscores the multifaceted relationship of genetic and lifestyle factors in the epidemiology of NCDs in South Africa. Metabolic risk factors contribute to four critical metabolic changes that increase the risk of non-communicable diseases, encompassing raised blood pressure, overweight/obesity, hyperglycemia (elevated blood glucose levels), and hyperlipidemia (elevated levels of fat in the blood) (Alamnia, Sargent & Kelly 2023). Some of the major precursors to NCDs in adulthood, such as metabolic syndrome, begin during adolescence (Akseer et al. 2020). According to Akseer et al. (2020), these metabolic risk factors account for nearly 70% of all premature deaths in adults.

The body composition of adolescents, including measurements such as body mass index (BMI), body fat percentage, and waist circumference, is associated with the risk of developing non-communicable diseases (NCDs) (Galan-Lopez et al. 2019; Freedman et al. 2017). Furthermore, Daniels et al. (2015) reported that a higher waist circumference, which indicates excess central adiposity, serves as a significant risk factor for NCDs among adolescents. Obesity prevalence among children and adolescents (aged 5–19 years) has increased worldwide from 0.7% in 1975 to 5.6% in girls and 7.8% in boys in 2016 (Jebeile et al. 2022).

In South Africa, recent findings from the 2013 and 2016 South African National Health and Nutrition Examination Surveys (SANHANNES-1) show alarming trends in adolescent overweight and obesity. The prevalence among adolescents aged 10- to 14-year-olds increased from 10.2% in 2013 to 21.56% in 2016 (Gerber et al. 2022). Similarly, in Limpopo, 35% of adolescents are classified as overweight or obese. South Africa has the greatest prevalence of adolescent overweight and obesity in sub-Saharan Africa, with 19% of boys and 26% of girls under 20 falling into these categories (Akseer et al. 2020; Kamkuemah et al. 2021; Nwuso et al. 2022).

Additional data by Goon et al. (2013) reveals that among boys, 2.4% are classified as obese and 10.9% as overweight, whereas for girls, the rates are higher at 4.8% and 17.5%, respectively. Consequently, South African girls show a greater vulnerability to obesity or overweight conditions compared to boys (Nwuso et al. 2022). Physiological difference contributes to a higher predisposition to obesity and overweight conditions among girls (Goon et al. 2013).

A higher body fat percentage has also been linked to an elevated risk of non-communicable diseases (NCDs) among adolescents (Mujica-Parodi et al. 2009; Rossouw et al. 2012), and this prevalence has been on the rise (Reddy et al. 2020).

Research shows that girls tend to have a higher body fat percentage than boys. Goon et al. (2013) found that girls had a greater body fat percentage (22.7 ± 5.7%) compared to boys (16.1 ± 7.7%). Wrottesley's et al. (2020) comprehensive review of adolescent nutrition in South Africa found comparable results, adding that body fat percentage (%fat) tends to be lower in boys compared to girls. Lugowska and kalanowski. (2022) also found similar results supporting the concepts that that adolescent girls generally have higher levels of body fat than boys. Girls tend to accumulate more fat than which could be attributed to a variety of causes including various factors such as differences in fat metabolism, hormonal differences, and genetic predisposition (Lugowska & Kalanowski. 2022).

Adolescents with high body fat percentages, poor body composition, and low levels of physical activity are inclined to also present with added risk factors, such as hypertension, elevated cholesterol levels, and disrupted blood glucose metabolism (Balakumar et al. 2016; Urbina et al. 2018). According to a systematic review and meta-analysis, the global prevalence of hypertension in adolescents is estimated to be around 1% to 5% (Noubiap et al. 2017). Another systematic review and meta-analysis of increased blood pressure among adolescents in sub-Saharan Africa found that the reported prevalence of elevated blood pressure ranged from 0.2% to 25.1% (Chen et al. 2023) However, specific findings in South Africa reveal significant variety. Joubert et al. (2021) reported a wide range in adolescent hypertension prevalence within the African population, spanning from 0.2% to 24.8%. Nkeh-Chungang et al. (2015) conducted a study focusing on adolescents in Mthatha, South Africa, and found a hypertension prevalence of 21.2% within this demographic. Furthermore, a cross-sectional study conducted in socioeconomically disadvantaged areas found that 18% of children and adolescents were classified as hypertensive, based on systolic or diastolic blood pressure (Joubert et al. 2021). In disadvantaged areas, socioeconomic factors such as poor nutrition, lack of physical activity, and limited access to healthcare contribute to the higher prevalence of hypertension in children (Riley & Bluhm. 2012).

Regular physical activity, including both high-intensity exercises and low-intensity activities such as walking, cycling, wheeling, active recreation, sports, playing, and activities of daily living (ADL), is critical in the prevention of non-communicable diseases (NCDs) among adolescents, according to the World Health Organization (WHO. 2019).

According to Biddle et al. (2019), Elevated levels of physical activity associated with a lower Body Mass Index (BMI), lower body fat percentage, improved lipid profiles, and increased glucose metabolism. Globally, it is estimated that 80% of adolescents are insufficiently active, with many engaging in more than 2 hours of daily recreational screen time (van Sluijs et al. 2021). The World Health Organization (WHO) physical activity guidelines for adolescents at risk for NCDs recommend accumulating at least an average of 60 minutes of moderate-to-vigorous physical activity (MVPA) per day to attain the most health benefits from physical activity (Saqib et al. 2020). According to Ackah et al. (2022), a multi-country analysis of Global School-based Health Surveys report that only 20% of adolescents in Africa engage in sufficient physical activity.

Approximately 25% of boys met the World Health Organization (WHO) recommendation for sufficient physical activity exercise, contrasting with a lower rate of 16% among girls (Ackah et al. 2022). This observed sex discrepancy may be attributed to entrenched traditional and religious norms prevalent found in many North African countries. These norms include the requirements for unmarried women to have accompanying companions in public places, the impracticality of traditional attires for engaging in physical activities, and scarcity and accessibility of gender-specific fitness facilities due to safety concerns (Sharara et al. 2018). The Healthy Active Kids South Africa (HAKSA) Report Card is aa comprehensive document presenting the most recent and rigorous evidence concerning the physical activity levels of children and adolescents in South Africa (Aubert et al. 2022). The report card includes three primary categories of indicators: physical activity, nutrition, and body composition. The physical activity indicators are aligned with a broader international effort through alignment with the Active Healthy Kids Global Alliance (Draper et al. 2019). In the Healthy Active Kids South Africa (HAKSA) 2018 Report Card, grades ranging from A to F were issued to each indicator within the three categories to evaluate the physical activity, nutrition, and body composition of South African children and adolescents (Draper et al. 2019). According to the HAKSA2018 Report Card, the grade for physical activity, nutrition, and body composition of South African children and adolescents was a grade C (Grade C): Following with just over half of children with a percentage of (41–60%) (Draper et al. 2019).

According to the HAKSA 2018 Report Card, only 7% of South African adolescents adhered to the physical activity guidelines recommended by the World Health Organization (WHO), This report highlights the urgent requirement for the creation of additional safe and accessible avenues for engaging in physical activity (Draper et al. 2019).

Gerber et al. (2018) reported a rapid increase in non-communicable diseases (NCDs) and related risk factors, placing South African adolescents at a heightened risk and potentially leading to detrimental consequences for their development and general well-being. There is a lack of studies specifically addressing adolescents at risk for non-communicable diseases, particularly in terms of body composition and physical activity and even more so for South African adolescents in the Eastern Cape region. Thus, this study aims to compare adolescents at risk and not at risk for NCD in terms of body composition and physical activity in the Eastern Cape, South Africa.

METHODS

STUDY DESIGN AND DATA COLLECTION

This study adopted a cross sectional design and a quantitative research approach. The body composition, physical activity, and metabolic risk were measured as follow:

- Body composition: Height, weight, and four skinfolds (triceps; subscapular; illiospinale; calf) were measured with Harpenden skinfold caliper, manufactured by Naugramedical, a leading Harpenden Skinfold Calliper manufacturer and supplier in India, China (Leger et al. 1982). The BMI of participants was calculated by weight in kilogram over height in centimetres squared (BMI = weight(kg)/height(cm)^2. The Waist-to-hip ratio was calculated by girth included (arm girth, hip girth, and waist girth). All body composition variables were measured by accredited Level 1 ISAK (International Society for the Advancement of Kinanthropometry) anthropometrists. Each measurement was done twice to determine the average value. The following equation was used to calculate body fat percentage (Boys: % Body Fat = 0.735 (Triceps + Calf) + 1.0, and for Girls: % Body Fat = 0.610 (Triceps + Calf) + 5.1) (Slaughter et al. 1988). The sum of 4 skinfolds was done by adding all the skinfolds which included (triceps + subscapular + illiospinale + calf). The percentage of fat was calculated using Slaughter's equation (Slaughter et al. 1998). The classification of healthy fat% in boys was (<25%), healthy fat% in girls (<30%), unhealthy fat% in boys (≥25%), and unhealthy fat% in girls (≥35%).
- Physical activity: Physical activity level was assessed indirectly, through the administration of the International Physical Activity Questionnaires (IPAQ) long form. The IPAQ is a 27-item self-reported measure of physical activity (Craig et al. 2017) it includes four domains (exercise-related physical activity, work or school-related physical activity, transport-related physical activity, housework-related physical activity, and total physical activity). The reliability and validity of the International Physical Activity Questionnaire (IPAQ) have been assessed in various studies, with some differences in the results depending on the specific version of the questionnaire and the population it was used with, demonstrating good test-retest reliability and concurrent validity when compared to objective measures like accelerometers (Craig et al. 2017; Lee et al. 2011; Hagströmer et al. 2006). These findings support the credibility and appropriateness of the IPAQ for assessing physical activity levels in research studies.
- Metabolic risk: Random blood glucose and cholesterol levels of participants were measured by a professional nurse using an ACCUTREND PLUS C02/8© unit and a droplet of blood from the index or ring finger of the participants. Blood pressure was measured by

the professional nurse with the use of a CONTEC08 A/C© digital blood pressure monitor, using a cuff that was fitted on the left upper arm of the participant to measure the systolic and diastolic blood pressure. Blood pressure was measured twice, to determine the average value to ensure interrater and intrarater reliability. The professional nurse used standardized protocols, regular calibration and maintenance of equipment, and repeated measurements for consistency and reliability. The same professional nurse also measured all the participants.

SAMPLING

The total adolescent population in the Eastern Cape is approximately 22.7% of the total population, which totals 2,473,140 adolescents (Stats. 2018). A sample size calculator (http://www.raosoft.com/samplesize.html) was used to determine the sample size necessary to achieve an alpha level of.05 and elicit a 90% confidence level with a power analysis estimated at 80% and a large effect size. The desired sample size was originally set at 270. However, the study was only able to collect data from 257 adolescents, which resulted in a dropout rate of 4%. This was due to one school withdrawing from the study.

This study employed a stratified random sampling method to select participants. Participants were selected from two (2) of the six (6) districts (Amatole district and Buffalo City Metropolitan Municipality) in the Eastern Cape due to proximity. Four (4) schools, using a randomized computer-based tool in Microsoft Excel, were randomly selected from each of the Amatole district and the Buffalo City Metropolitan Municipality districts in the Eastern Cape. However, one school in the Amatole district withdrew from the study, thus, only seven (7) schools participated. The schools were selected from both quintiles 1–3 and quintiles 4–5 to ensure a diverse representation of different socioeconomic backgrounds. School Quintiles are categorized between Quintile 1 schools, representing schools in the most economically disadvantaged (poorest) geographic areas, and Quintile 5 schools located, representing those in the most economically advantaged geographical areas (wealthiest) (Ogbonnaya & Awuah 2019). Schools in Quintiles 1 to 3 are non-fee-paying schools and receive more funding per learner from the government than schools in Quintiles 4 and 5 (Ogbonnaya & Awuah 2019). Adolescents exhibiting one or more of the metabolic risk factors were classified as "at risk," whereas those devoid of any metabolic risk factors were categorized as "not at risk."

STATISTICAL ANALYSIS

This study used the Statistical Package for Social Sciences Software (SPSS) (Version 28) (IBM, 2021) to analyse the data. Descriptive statistics were utilized to investigate the characteristics of adolescents who had either one or more metabolic risk factors (at risk) or no metabolic risk factor (not at risk) associated with NCDs. Four metabolic risk factors were included in the study. The criteria for classifying adolescents into the two groups were based on specific cut-off scores, including BMI (>30), cholesterol (>6.21 mmol/L), random blood glucose (>7 mmol/L), and blood pressure (>140/90).

The data was presented in the form of means and standard deviations (SD) as well as frequencies and percentages to describe the characteristics of the study sample.

Independent samples T-tests were used to examine group differences among adolescents in both at risk and not at risk groups. A parametric test was used as the assumptions for the test were not violated. The data followed a normal distribution as indicated by the histograms inspected for skewness and Levene's test for equality (homogeneity) was not significant. The researchers verified that the data met the assumptions of the T-test, The study employed independent observations among participants, utilizing a randomly selected sample. The variables under consideration included continuous measures such as body fat percentage, sum of 4 skinfolds, waist-to-hip ratio, and physical activity domains. The statistical significance level was established at $p < 0.05$. Furthermore, chi-square tests were conducted to ascertain the significant associations between categorical variables, namely fat percentage, waist-to-hip ratio, and physical activity domains. Additionally, logistic regression analysis was employed to predict the influence of gender, body fat, sum of skinfolds, waist-to-hip ratio, and total physical activity on the likelihood of presenting metabolic risk, which is correlated with the risk of non-communicable diseases (NCDs).

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RESEARCH ETHICS

This study forms part of a larger research project titled "An intervention to combat the physical, physiological and psychological risk factors associated with non-communicable diseases among adolescents in the Eastern Cape, South Africa" funded by a South African Medical Research Council Research Capacity Development Grant 2020–2023. The project obtained ethical clearance from the University Health Research Ethics Committee (HREC) Ref #2021 = 03 = 01 = van Gent M.

This specific study also obtained ethical clearance (HREC #Ref = 2022 = 05 = 08 = Mvula S) from the HREC. Parental consent forms were distributed to parents or guardians of the adolescents, with information relating to the study. The purpose of the study and the procedures involved were explained to parents/guardians and parental consent was obtained. After parental consent was obtained, child assent was obtained for all participants who wanted to participate in the study. Additionally, participant anonymity and confidentiality were upheld by safeguarding the privacy of collected data through the utilization of participant codes instead of actual names. This approach ensured the anonymity and privacy of the participants throughout the entirety of the study.

RESULTS

In Table 1, the results for the descriptive statistics are presented, indicating that 131 (50.9%) of adolescents were classified as at risk for NCDs. As expected, this group exhibited higher mean values across most variables, except for height. It was observed that the mean BMI (25.49 ± 6.11) score of the at-risk group classified them in the overweight category, which is the only variable that was above acceptable norms.

VARIABLES	AT RISK n = 131 (50.9%)		NOT AT-RISK n = 126 (49.1%)	
	MEAN	SD	MEAN	SD
Age	14.81	1.18	15.13	1.26
Height (cm)	159.39	7.75	163.00	7.86
Weight (kg)	64.76	16.30	52.65	7.40
Triceps SF (mm)	17.70	6.99	10.51	4.76
Subscapular SF (mm)	15.44	7.45	8.43	3.46
Illiospinale SF (mm)	13.14	5.93	7.37	3.75
Calf SF (mm)	19.18	7.59	12.74	5.85
Waist (cm)	74.23	10.91	65.70	5.29
Hip (cm)	99.82	12.44	87.93	6.08
Body Mass Index (BMI)	25.49	6.14	19.77	2.01
Systolic Blood Pressure (mmHg)	121.02	14.83	115.60	12.00
Diastolic Blood Pressure (mmHg)	70.45	13.59	64.38	11.01
Random Blood Glucose (mmol/L)	4.26	1.51	4.04	1.29
Blood Cholesterol (mmol/L)	3.75	1.59	2.79	1.50

Table 1 The descriptive statistic of adolescents at risk and not at risk of non-communicable diseases.

SF = Skinfolds, n = total number of participants, SD = Standard deviation.

Risk group comparisons are presented in Table 2. The significant differences between the groups classified as 'at risk' and 'not at risk' were observed for the body fat percentage for both girls (p = 0.000) and boys (p = 0.000), the sum of 4 skinfolds (p = 0.000), and housework-related physical activity (p = 0.025). There was no statistically significant difference in the total physical activity levels between the two groups. It is also worth noting the total weekly physical activity minutes for both groups met the minimum WHO requirements of 300 minutes per week.

VARIABLES	AT RISK n = 131	NOT AT RISK n = 126	SIGNIFICANCE
Body Fat percentage (Girls) (%)	30.80 ± 6.82	24.42 ± 4.89	0.000*
Body Fat Percentage (Boys) (%)	18.92 ± 8.71	13.51 ± 4.59	0.000*
Sum of 4 Skinfolds (mm)	64.48 ± 25.30	39.02 ± 16.19	0.000*
Waist to Hip ratio (n)	0.74 ± 0.05	0.749 ± 0.06	0.414
Exercise related physical activity (minutes per week)	118.13 ± 167.86	171.19 ± 367.23	0.135
Work related physical activity (minutes per week)	159.77 ± 225.04	163.65 ± 215.53	0.888
Transport related physical activity (minutes per week)	69.48 ± 88.99	87.03 ± 123.34	0.191
Housework related physical activity (minutes per week)	100.04 ± 119.53	154.91 ± 249.87	0.025*
Total physical activity (minutes per week)	447.44 ± 462.90	576.80 ± 678.71	0.074

Table 2 The comparison of adolescents at risk and not at risk for NCD in terms of body fat percentage, sum of 4 skin folds, waist to hip ratio and physical activity.

*Statistical significance = p < 0.05, n = total number of participants.

Table 3 presented the association between NCD risk and gender for fat percentage, waist-to-hip ratio, and physical activity. Significant associations were found for boys (p = 0.000), between classification type of fat (healthy and unhealthy) and being at risk for NCDs. Of the boys displaying elevated levels of unhealthy body fat, 83% were classified within the at-risk group. This association resulted in a large effect size (0.402). Similarly, for the girls, a significant association (p = 0.000), between the classification of fat (healthy and unhealthy) and being at risk for NCDs was observed. All the girls presented with unhealthy fat and were in the at-risk group. This association also resulted in a large effect size (0.375). No other significant association was found for other variables.

VARIABLES		CATEGORIES	AT RISK n = 131	NOT AT RISK n = 126	P VALUE	EFFECT SIZE
Fat percentage	Boys	Healthy Fat % (<25%)	n = 23 24.7%	n = 70 75.3%	0.000*	0.402
		Unhealthy Fat% (≥25%)	N = 10 83.3%	n = 2 16.7%		
	Girls	Healthy Fat % (<30%)	n = 54 51.4%	n = 52 48.6%	0.000*	0.375
		Unhealthy Fat% (≥30%)	n = 22 100%	n = 0 0%		
Waist to Hip ratio	Boys	Healthy WHR (<0.90)	n = 34 31.8%	n = 73 68.2%	–	–
		Unhealthy WHR (>0.90)	n = 0 0%	n = 0 0%		
	Girls	Healthy WHR (<0.85)	n = 94 63.9%	n = 53 36.1%	0.494	0.106
		Unhealthy WHR (>0.85)	n = 3 2%	n = 0 0%		
Physical activity	Boys	Healthy (>300 min/week)	n = 23 31.9%	n = 49 68.1%	0.957	0.005
		Unhealthy (<300 min/week)	n = 11 31.4%	n = 24 68.6%		
	Girls	Healthy (>300 min/week)	n = 44 62%	n = 27 38.0%	0.629	0.053
		Unhealthy (<300 min/week)	n = 53 67.1%	n = 26 32.6%		

Table 3 Chi-square analyses of fat percentages, waist to hip, And physical activity for adolescents at risk and not at risk for NCD's.

*Statistical significance = p < 0.05, n = total number of participants.

Table 4 presented the results of the logistic regression analysis, which aimed to determine how factors such as body fat percentage, the sum of 4 skinfolds, waist-to-hip ratio, total physical activity, and gender predict the probability of being categorized as at risk for non-communicable diseases (NCD) according to metabolic risk factors.

Table 4 Logistic regression of variables predicting NCD among adolescents according to body fat percentage, sum of 4 skinfolds, waist-to-hip ratio, total physical activity, and gender.

	B	S.E	WALD	DF	SIG.	EXP(B)	95%C.I. FOR EXP(B)	
							LOWER	UPPER
Body fat Percentage	–0.137	0.082	2.814	1	0.093	0.872	0.743	1.023
Sum of 4 Skinfolds	0.115	0.032	13.152	1	0.000*	1.122	1.054	1.194
Waist to Hip ratio	–2.055	3.220	0.407	1	0.523	0.128	0.000	70.573
Total Physical Activity	–0.001	0.000	4.275	1	0.039*	0.999	0.999	1.000
Gender	–0.497	0.456	1.187	1	0.276	0.609	0.249	1.487
Constant	0.725	2.562	0.080	1	0.777	0.485		

*Statistical significance = $p < 0.05$.

The full model containing all predictors was statistically significant x^2 (5, N = 236) = 81.09 $p < 0.05$, indicating that the model was able to distinguish between at risk and not at risk adolescents. The model explained between 29.1% and 38.8% of the variance in metabolic risks, and correctly classified 75.4% of the cases.

Two variables contributed significantly to the prediction of metabolic risk among adolescents. The first variable was the sum of skinfolds (p = 0.000), with an odds ratio of 1.12, which indicated that adolescents who presented with a high sum of 4 skinfolds were 1.12 times more likely to develop metabolic risk diseases. Total physical activity, demonstrated an odds ratio of 0.99 (p = 0.039), suggesting that for each additional minute of physical activity, adolescents were 0.99 times less likely to develop metabolic risk.

DISCUSSION

The objective of this study was to compare adolescents categorized as at-risk for non-communicable diseases with those deemed not at risk, focusing on aspects related to body composition and physical activity. Limited studies were found that compared adolescents at risk and not at risk for non-communicable diseases.

Just more than half of the adolescents presented with one or more metabolic risk factors. Biswa et al. (2022) reported that the prevalence of four or more NCD risk factors is approximately 44% among adolescents globally, while Uddin et al. (2020) reported that 82.4% of adolescents worldwide had 2 or more risk factors.

According to a study conducted between 1998 and 2016, an average BMIs of 21.45–22.40 kg/m2 were reported for South African adolescents aged 15–19 years (Nwosu et al. 2022). The are limited studies reporting the BMI of adolescents classified at risk and not at risk for non-communicable diseases. This study found a higher BMI for adolescents at risk for NCDs (25.49 ± 6.14) than that reported by Nwosu et al. (2022), and classified them as overweight, as was reported by Gerber et al. (2022), that adolescents are overweight/obese (NCDs).

A high body fat percentage in adolescents was linked to a greater risk for non-communicable diseases (NCDs), as shown in a study by Harrison et al. (2015). This study found that both boys and girls who were at risk for NCDs had a high unhealthy body fat percentage. Furthermore, the body fat percentage of girls at risk was much higher compared to that of boys. Several studies (Goon et al. 2013; MacKelvie et al. 2019; Micklesfield et al. 2015) demonstrated similar findings and reported slightly higher body fat percentage in girls compared to boys. While the studies conducted by Mickesfield et al. (2015) and MacKelvie et al. (2019) yielded similar findings to the present study, it is important to note that variations in age groups were evident. A heightened body fat percentage often signifies an increased risk of cardiovascular issues, overweight, and obesity (Powell-Wiley et al. 2021). Contrary to some publications that propose a singular cut-off for body fat percentage to define obesity (25% in boys and 30% in girls) (Marques-Vidal et al. 2008), this study identified that almost a quarter of boys classified as at risk had a body fat percentage below 25%, while just over half of girls at risk had a body fat percentage below 30%.

The higher fat accumulation in girls compared to boys might be due to the increase of physical activity among boys compared to girls (Goon et al. 2013).

Some studies reported that the waist-to-hip ratio is associated with NCD risk factors in adolescents, including obesity and metabolic syndrome (Widjaja et al. 2023). However, this is slightly contradicting to the findings of this study. The findings of this study revealed that all the boys, either classified at risk or not at risk for non-communicable diseases had healthy waist-to-hip ratios. Therefore, waist to hip ratio in this study might not be a contributing factor for risk among adolescent boys and girls.

According to Florence et al. (2023), a substantial percentage of South African adolescents are insufficiently active, despite physical activity requirements of only 30 minutes each day. There are limited studies comparing adolescents at risk and not at risk for non-communicable diseases in terms of total physical activity. However, based on the findings of this study it was noted that both adolescents at risk and not at risk for non-communicable diseases met the minimum WHO (Saqib et al. 2020) requirements of 300 minutes of total physical activity. The findings of this study indicate an absence of a significant difference in the levels of physical activity among different groups of adolescents, irrespective of their risk status for non-communicable diseases (NCDs). The promotion of regular physical activity is crucial, as it not only confers various health benefits but also cultivates healthy habits, thereby mitigating the risk of various non-communicable diseases. In this study, two prominent factors emerged as significant contributors to the prediction of metabolic risk among adolescents: the cumulative measurement of skinfolds and the level of physical activity. Adolescents exhibiting higher levels of body fat linked with lower levels of physical activity were found to be at an elevated risk of developing metabolic risk. Skinfold measurements, assessing subcutaneous adiposity, provide insights into fat distribution, distinguishing it from other metrics such as body mass index (BMI), which primarily measures overall weight and cannot differentiate between lean and fat mass.

The study suggests a higher sum of skinfold thickness, indicative of higher adiposity, is linked to an elevated risk of metabolic issues in adolescents. Conversely, higher levels of physical activity are associated with a slightly reduced risk. These findings underscore the importance of both monitoring body composition, as indicated by skinfolds, and promoting physical activity in adolescents as measures to mitigate metabolic risk.

CONCLUSION

This study provides valuable insights into the factors impacting metabolic risk, leading to non-communicable diseases (NCDs) among adolescents, emphasizing the critical role of both body composition, as indicated by skinfold measurements, and levels of physical activity. The significance of these findings lies in their ability to inform the development of effective preventive and intervention strategies. By recognizing the interconnected impact of certain body composition methods and physical activity, this research contributes to the broader effort aimed at improving the health outcomes of adolescents. Furthermore, the study underscores the considerable importance of body fat as a significant risk factor for NCDs among adolescents. Although physical activity is still seen as a risk factor, it does not appear to be the primary risk factor for NCDs among adolescents in the Eastern Cape, South Africa.

As a result, the study encourages targeted interventions specifically tailored to address body fat percentage to alleviate the development of NCDs within this specific population. These interventions are crucial for promoting healthier outcomes and aligning with the unique health challenges faced by adolescents in the Eastern Cape, South Africa.

LIMITATIONS

The study's findings may not be generalizable to the broader South African population due to the selection of only two districts in the Eastern Cape, South Africa. Additionally, the withdrawal of one school resulted in a 4% dropout rate, leading to a 5.04% margin of error. Furthermore, the researchers did not investigate other socio-economic factors such as the level of nutrition and household income, which can impact non-communicable disease risk factors among adolescents. Another limitation is that physical activity was measured indirectly.

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Therefore, it is suggested that future studies should be expanded to a broader population of South Africa. Longitudinal studies are needed to measure or assess changes in non-communicable disease risk factors over time. In future studies, the use of physical activity trackers such as pedometers is recommended to obtain more accurate measurements of physical activity levels.

DATA ACCESSIBILITY STATEMENT

The data supporting the findings of the current study are available from the corresponding authors on reasonable request.

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COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHORS CONTRIBUTIONS

M.S., M.VG., and L.VN. conceptualized the project. L.VN. conducted the statistical analysis. S.M. wrote the introduction and literature review. S.M. and M.VG. interpreted the results and discussion. All authors reviewed the final manuscript.

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