Poor sleep quality, low physical activity and low-to-moderate diet quality in South African first-year medical students

J Borresen,[1] PhD; **B Celie,**[1] PhD; **R Laubscher,**[2] BComm; **M Bac,**[3] MD; **P Wood,**[1,4] PhD; **T Camacho,**[4] MA; **K Nolte,**[4] DPhil; **M Schwellnus,**[5] MB ChB; **D Basu,**[6] PhD; **M P Schwellnus,**[1] MB BCh

[1] *Sport, Exercise Medicine and Lifestyle Institute (SEMLI) and IOC Research Centre of South Africa, Faculty of Health Sciences, University of Pretoria, Pretoria, South Africa*
[2] *Biostatistics Unit, South African Medical Research Council, Cape Town, South Africa*
[3] *Department of Family Medicine, Faculty of Health Sciences, University of Pretoria, Pretoria, South Africa*
[4] *Department of Physiology, Faculty of Health Sciences, University of Pretoria, Pretoria, South Africa*
[5] *School of Medicine, Faculty of Health Sciences, University of Pretoria, Pretoria, South Africa*
[6] *Department of Public Health Medicine, Faculty of Health Sciences, University of Pretoria, Pretoria, South Africa*

Corresponding author: *J Borresen (jill.borresen@up.ac.za)*

Background. The personal health behaviours and lifestyle habits of health professionals influence their counselling practices related to non-communicable diseases (NCDs). There is limited evidence on the prevalence of modifiable NCD risk factors among medical students in South Africa (SA).
Objectives. To determine the prevalence of modifiable behavioural and metabolic NCD risk factors in first-year medical students at a SA university.
Methods. This cross-sectional observational study included 256 first-year students. Participants completed five online questionnaires regarding lifestyle behaviours (physical activity, dietary habits, smoking, alcohol consumption and sleep quality). NCD-related metabolic markers including body composition, blood pressure, total cholesterol and random glucose concentrations, were measured. The prevalence of risk factors was calculated using internationally accepted criteria, and sex differences were reported using one-way ANOVA or χ^2 test ($p<0.05$).
Results. The prevalence of poor sleep quality was 79.7%, followed by low-to-moderate diet quality (66.8%), low levels of physical activity (64.1%), overweight/obesity (26.2%), current/past smoking (13.3%) and harmful use of alcohol (12.5%). Most (88.3%) participants had two or more NCD-related risk factors. The prevalence of multiple NCD risk factors differed significantly between male and female participants, with more male participants having ≥2.
Conclusions. This study found that first-year medical students at a South African university have a high prevalence of lifestyle-related risk factors, specifically poor sleep quality, low levels of physical activity and low-to-moderate diet quality. Sleep hygiene, regular activity and good nutrition should be promoted, and interventions focusing on nutrition, smoking cessation and alcohol consumption could be targeted by sex.

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Non-communicable diseases (NCDs) are the leading cause of death and morbidity globally, being responsible for ~70% of all deaths.[1] The World Health Organization (WHO) estimated that in 2012, 62.1% of premature (<70 years of age) NCD deaths in South Africa (SA) occurred in males, and 47.8% in females. However, it is evident that people of all ages, regions and countries are vulnerable to the risk factors contributing to NCDs. Physical inactivity, unhealthy diet, tobacco use and the harmful use of alcohol are regarded as the most important modifiable behavioural contributors to the development of NCDs.[1] These risk factors have been shown to lead to four key metabolic changes that markedly increase the risk of developing NCDs, including elevated blood pressure, overweight/obesity, raised blood glucose and cholesterol.[1] Additionally, epidemiological evidence adds poor sleep to this list of behavioural risk factors.[2]

There is evidence that the personal health behaviours of health professionals impact their counselling practices and thus the health behaviours of their patients and the broader community.[3-6] Non-smoking medical doctors who engage in regular physical activity, maintain good nutritional habits and have a healthy body composition are more likely to prescribe lifestyle behavioural changes and are generally perceived as more credible by their patients.[3-6] Some evidence suggests that NCD risk factors such as physical inactivity are highly prevalent among medical doctors.[6] Given the importance of adopting a healthy lifestyle to prevent NCDs and the central role of current and future healthcare professionals in this effort, it is essential to better understand the prevalence of NCD risk factors among future health professionals.

Therefore, the primary aim of this study was to determine the prevalence of modifiable behavioural and metabolic NCD risk factors in a cohort of first-year medical students. First-year students are in a critical transition phase in their education in preparation for a career in clinical medicine. Secondary outcomes were to report differences in the prevalence of NCD risk factors by sex and the prevalence of multiple NCD risk factors. Lifestyle is a key area in preventing NCDs, so research involving this group can provide insights into behaviours, challenges and experiences during this pivotal period. Subsequent studies could track a cohort over time to observe developments and provide valuable longitudinal data. The findings from this research may be used to inform educational strategies and support

services early in the medical curriculum, potentially improving student outcomes and wellbeing throughout their medical education.

Methods

Participants and procedures

This study was a cross-sectional observational study conducted in 2019. Purposive sampling was adopted, whereby 333 registered first-year medical students at the University of Pretoria were invited to participate in the study. A research team member presented the purpose and relevance of the research and outlined the methodology to the medical student class. The students were given an opportunity to ask questions and were provided with a participant information sheet containing details of the study processes, potential risks and benefits of participating. The students were then sent a link to register on the online data collection platform where they could complete the questionnaires. Students who chose to participate in the study provided their informed consent electronically on the data collection platform. In total, 256 consented to participate. In July, all participants completed five online questionnaires about their lifestyle behaviours, and in October, they were assessed for potential metabolic NCD risk factors. Each participant was allocated a unique identifier code to ensure data were analysed in a de-identified manner. Participants were advised to consult medical personnel at the on-campus Student Support Services if they wanted to discuss their health behaviours or measurements and how to improve them. Research ethics approval was obtained from the Faculty of Health Sciences Research Ethics Committee at the University of Pretoria (REC no: 104/2019).

Outcome measures

Questionnaire data were collected from consenting students via the online Smartabase platform/app (Fusion Sports Pty(Ltd), Australia) while anthropometric, physiological and metabolic assessment data were manually entered into a Microsoft Excel spreadsheet (Microsoft Corp., USA).

Behavioural risk factors

Tobacco use was assessed using relevant sub-sections of the WHO/Centers for Disease Control (CDC) Global Adult Tobacco Survey (GATS), which monitors tobacco use among adults of 15 years and older.[7] Data on current and past smoking were collected, with a response of '*Daily*' indicating smoking risk. The WHO Alcohol Use Disorder Identification Test (AUDIT) is a 10-item questionnaire used to screen adults for harmful alcohol consumption.[8] Total AUDIT scores range from 0 - 40, with a score higher than 8 indicating harmful alcohol use. The Kasari FIT Index was used to assess levels of habitual physical activity, calculated from responses on the activity questionnaire scale (FIT = Frequency (F) × Intensity (I) × Time (T)).[9] Total Kasari FIT Index scores range from 1 (physically inactive) to 100 (very physically active). A total FIT score of 36 or lower indicated low habitual physical activity.[9] The short version Rapid Eating Assessment for Participants (REAP-S), was used to assess diet quality in daily life.[10] Possible total REAP-S scores range from 13 - 39 with a higher score indicating a higher diet quality. Scores of 15 - 19, 20 - 29 and 30 - 39 indicated a Low, Moderate and Good diet quality, respectively.[11] The Pittsburgh Sleep Quality Index (PSQI) is a self-assessment of sleep quality and disturbances in the previous month.[12] The combined scores of seven sub-components determine the global sleep quality score, with higher scores indicating poorer sleep quality and lower scores indicating better or good sleep quality. A global score >5 is a clinical cut-off used for poor sleep quality.[12]

Metabolic risk factors

Standardised anthropometric measurements were taken by trained senior healthcare students and qualified staff. Waist circumference (cm) was measured with a steel anthropometric measuring tape at the midpoint between the lowest rib cage and the top of the iliac crest. Hip circumference (cm) was taken at the widest lateral extension of the hips. Body mass (kg), height (cm) and body fat percentage (%) were measured using the InBody770 multi-frequency bioelectrical impedance device (InBody Co Ltd, Korea). BMI was calculated as body mass (kg) divided by height squared (m^2). Body composition-related thresholds based on WHO criteria were used to group the medical students into different risk categories.[13] Resting systolic blood pressure (SBP, mmHg) and diastolic blood pressure (DBP, mmHg) were measured using an IntensCare Automated Blood Pressure Monitor (Pharmamark, SA). To obtain these measures, participants were seated with their left arm supported at heart level and an appropriately sized cuff secured snugly around the upper arm. Additionally, participants were asked to refrain from smoking or ingesting caffeine 30 minutes before the measurements, which were taken after at least 5 minutes of rest. The cut-off criteria used were: elevated BP ($120 \leq SBP \leq 129$ and $DBP < 80$) and suspected hypertension ($SBP \geq 130$ or $DBP \geq 80$).[14] Participants were not measured again on a different day, therefore stage 1 or 2 hypertension could not be confirmed.[14] Random total cholesterol concentration (mmol/L) was measured via finger prick using the CardioChek PA (Polymer Technology Systems Inc, USA). A total blood cholesterol concentration higher than 5 mmol/L was considered a risk factor for cardiovascular disease.[15] Random blood glucose concentration was measured via finger prick using CardioChek PA (Polymer Technology Systems Inc, USA). Random blood glucose concentration was classified as out of the normal range if >11.1 mmol/L.[16]

Statistical analysis

Statistical analyses were performed in 2021 using STATA Statistical Software 16 (STATA Corp., USA). A post-hoc power calculation was done using the FIT Index (score range 1 - 100) and the means and standard deviations of the 2019 data. Calculations indicated that a score change of more than 4 would show significance at a 5% level with 80% power for N=256. The normality of the continuous variables was checked using the Tukey ladder of powers. To detect cross-sectional differences between males and females in anthropometric, behavioural and metabolic profiles, a one-way analysis of variance (ANOVA) was used. The χ^2 test was used to assess differences by sex for categorical variables such as behavioural or metabolic risk factors and the number of clustered risk factors. The risk factors included in the cluster analysis were smoking, alcohol, physical activity, diet quality, BMI, blood pressure, cholesterol and glucose. There were no missing values on these indicators and the significance level was set at $p<0.05$.

Results

Study sample

A total of 256 (76.9% of the invited sample) registered first-year medical students from the University of Pretoria gave their consent to participate in this study (n=77 male and n=179 female; mean age 20.5 (2.4) years).

Prevalence of modifiable behavioural and metabolic risk factors

The prevalence of NCD risk factors in first-year medical students is presented in Figure 1. The NCD risk factors with the highest prevalence were poor sleep quality (79.7%), followed by low-to-moderate diet quality (66.8%) and low habitual physical activity (64.1%). Poor body composition indices (BMI and body fat %) were present in approximately one-quarter of the students. Suspected hypertension was prevalent in about one-third (34%) of the medical student cohort. However, these results should be interpreted with caution owing to a possible white coat effect and the lack of two measurements on separate days.

Prevalence of NCD risk factors comparison by sex

The prevalence of modifiable behavioural and metabolic risk factors in male v. female first-year medical students is shown in Table 1. In this cohort, significantly more male than female participants were at risk for harmful drinking behaviour (22.1% v. 8.4%, p=0.002) and current or past smoking (23.4% v. 8.9%, p=0.002). Female participants were significantly more likely than male participants to have a high (good) diet quality (38.0% v. 22.1%, p=0.007). However, females also reported exercising less than three times a week (61.0% v. 73.7%, p=0.042) and 60.3% reported that their exercise sessions were on average less than 30 minutes in duration compared with 46.8% of the male students (p=0.045). There was a significant difference in the distribution of the blood pressure categories between male and female participants, with more than half of the male cohort having a blood pressure measure indicating suspected hypertension, compared with 23.4% of female participants (p<0.001). A majority of the cohort had total blood cholesterol within the healthy range; however, significantly more females than males had a high total cholesterol (5.2% v. 15.6%, p=0.020).

Anthropometric, metabolic and health behaviour profiles of first-year medical students

Anthropometric, metabolic and health behaviour measurements for all participants and by sex are presented in Table 2. SBP was significantly higher in male than in female participants (131 (13) mmHg v. 118 (11) mmHg, p<0.001). Total blood cholesterol and resting heart rate were significantly lower in the males (3.4 (0.8) mmol/L v. 4.1 (0.9) mmol/L for cholesterol and 75 (12) bpm v. 81 (12) bpm for resting heart rate, p<0.001). Waist circumference and waist-to-hip ratio were significantly lower in the females (78.1 (9.7) cm v. 69.8 (9.5) cm and 0.79 (0.05) vs 0.72 (0.06), p<0.001, respectively). However, their body fat percentage was significantly higher than the male cohort (19.0 (8.8%) v. 31.0 (7.5%), p<0.001), and BMI was not significantly different.

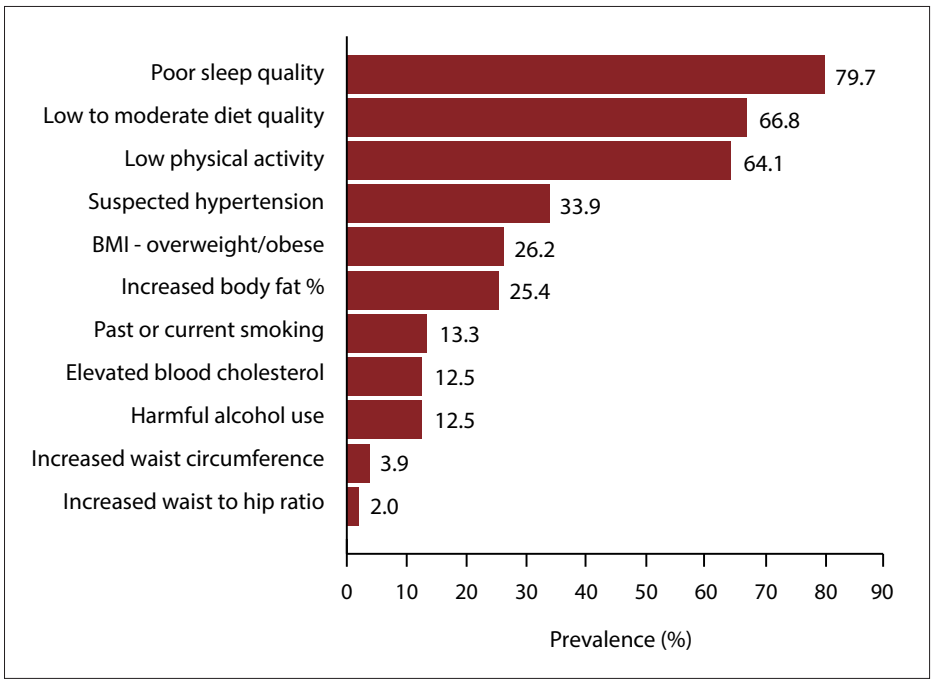

Fig. 1. Prevalence of non-communicable disease risk factors in a cohort of first-year medical students. (BMI = body mass index).

Prevalence of multiple NCD risk factors in first-year medical students

Among the students in this cohort, 88.3% had two or more modifiable behavioural or metabolic risk factors, while only 6.6% had no NCD risk factors. In this medical student population, female students had significantly fewer risk factors than male students. 92.2% of the male students v. 86.6% of the female students had two or more modifiable behavioural or metabolic risk factors (p<0.001).

Discussion

The first finding of this study is that first-year medical students report a high prevalence of poor sleep quality (79.7%). This is higher than the pooled prevalence of 52.7% previously reported in a meta-analysis that included 25 735 medical students worldwide.[17] The prevalence of poor sleep quality in the current study is similar to the highest recorded prevalence (76%) of poor sleep quality in that meta-analysis.[17] Another study has shown that poor sleep quality is associated with raised stress levels and anxiety among medical students.[18] The high academic expectations in the first year could be responsible for these elevated stress levels and could explain these results.[18] The data in the present study were collected before the COVID-19 pandemic, and it would therefore be interesting to note the effect of COVID-19 on stress levels.

More than two-thirds of the students reported low-to-moderate diet quality. These findings are in line with research conducted on students in the United Kingdom (UK).[19] The third most prevalent risk factor among the current research group was insufficient physical activity, with 64.1% reporting low habitual levels, which aligns with another study in similar cohorts.[20] This is of concern because regular physical activity is recommended by several international organisations as a key component in NCD prevention and treatment, owing to its wide range of health benefits.[1] The combination of poor diet and physical activity of these medical students could be due to various factors including the challenge of living independently for the first time without parental constraints, higher screen time, difficult access to healthy food, social

Table 1. Prevalence of modifiable behavioural and metabolic non-communicable disease risk factors in male and female first-year medical students

	Male (*n*=77)	Female (*n*=179)	
	n (%)	*n* (%)	*p*-value
Past or current smoking	18 (23.4%)	16 (8.9%)	0.002**
Harmful alcohol use (AUDIT score ≥8)	17 (22.1%)	15 (8.4%)	0.002**
Low physical activity (Kasari FIT index ≤36)	44 (57.1%)	120 (67.0%)	0.130
Moderate physical activity (Kasari FIT index >36; <64)	13 (16.9%)	30 (16.8%)	0.981
Low activity frequency (<3 times/week)	47 (61.0%)	132 (73.7%)	0.042*
Low-to-moderate intensity of activity	27 (35.1%)	72 (40.2%)	0.437
Duration of activity (<30 minutes/session)	36 (46.8%)	108 (60.3%)	0.045*
Low-to-moderate diet quality (REAP-S score ≤29)	60 (77.9%)	111 (62.0%)	0.007**
Low diet quality (13 - 19)	7 (9.1%)	11 (6.1%)	
Moderate diet quality (20 - 29)	53 (68.8%)	100 (55.9%)	
Poor sleep quality (PSQI score >5)	59 (76.6%)	145 (81.0%)	0.424
BMI (kg/m^2)			0.315
Underweight (<18.5)	4 (5.2%)	12 (6.7%)	
Overweight/ Obese (≥25)	25 (32.5%)	42 (23.5%)	
Body Fat (%)			
Increased (>25% males; >35% females)	14 (18.2%)	51 (28.5%)	0.082
Waist circumference (cm)			0.071
Increased (≥94 cm males; ≥80 cm females)	1 (1.3%)	15 (8.4%)	
Substantially increased (≥102 males; ≥88 females)	2 (2.6%)	8 (4.5%)	
Waist-to-hip ratio			
Increased (≥0.9 males; ≥0.85 females)	0 (0%)	5 (2.8%)	0.326
Blood pressure (mmHg)			<0.001***
Elevated (120≤SBP≤129 and DBP <80)	13 (16.9%)	39 (21.8%)	
Suspected hypertension (SBP ≥130 or DBP ≥80)	45 (58.5%)	42 (23.4%)	
Random blood cholesterol (mmol/L)			
Elevated blood cholesterol (>5)	4 (5.2%)	28 (15.6%)	0.020*
Random blood glucose (mmol/L)			
Elevated blood glucose (>11.1)	0 (0.0%)	0 (0.0%)	

*P<0.05
**P<0.01
***P<0.001
AUDIT = Alcohol Use Disorder Identification Test; REAP-S = Rapid Eating Assessment for Participants – short version; PSQI = Pittsburgh Sleep Quality Index; BMI = body mass index; SBP = systolic blood pressure; DPB = diastolic blood pressure.

drinking and less time to be physically active.[21,22] Also, NCD knowledge might not be sufficiently developed yet, as the current measurements and survey data collection took place during the first year of a bachelor's degree programme.

Healthcare practitioners who engage regularly in physical activity and have healthy diets are more likely to prescribe lifestyle behaviour changes to their patients.[3-6] Having medical doctors with a healthy lifestyle is crucial for fostering a healthier population. The percentage of medical students with poor sleep, unhealthy diet and physical inactivity reported confirms previous findings,[17,19,20] which emphasise the need to promote healthy lifestyles. These study findings can serve as a foundation for future interventions and curriculum development.

The present study identified 33.9% of the medical students with raised blood pressure and 26.2% were classified as overweight/obese. The results of this study are lower for BMI and blood cholesterol compared with studies investigating similar populations using similar methods.[20,23] While these studies revealed raised blood pressure in 8% - 42.6% of their medical students,[20,23] the present study found that one-third of all students had suspected hypertension, with a high prevalence in the male sub-group (58.5%). However, caution is needed when interpreting these results as measurements were only taken on one occasion. Nevertheless, this finding is still of concern as hypertension is the most important risk factor for cardiovascular disease.[14] According to the CDC, modifiable behavioural risk factors, age and stress are largely responsible for elevated blood pressure.

Almost nine out of ten participants in the current study had two or more NCD-related risk factors, and male students were significantly more likely to have multiple risk factors compared with female students. The present study showed a higher frequency of students with multiple risk factors compared with a recent Italian study,[20] which specifically investigated cardiovascular risk factors among medical students. That study included similar combined risk factors and found that 41.8% of their medical students had no risk factors. This is considerably better than the results from our study, and the presence and clustering of risk factors among the study cohort of medical students is of concern. Further research should investigate this

Table 2. Anthropometric, metabolic and health behaviour profiles of first-year medical students

	All	Male (*n*= 77)	Female (*n*=179)	
		Mean (SD)		*p*-value
Body mass (kg)	65.4 (15)	74.9 (16.1)	61.3 (12.5)	<0.001***
Body Height (cm)	166.3 (9.4)	175.8 (8.3)	162.2 (6.5)	<0.001***
Waist circumference (cm)	72.3 (10.3)	78.1 (9.7)	69.8 (9.5)	<0.001***
BMI (kg/m^2)	23.5 (4.3)	24.1 (4.6)	23.2 (4.2)	0.122
Body fat (%)	27.4 (9.6)	19.0 (8.8)	31.0 (7.5)	<0.001***
Hip circumference (cm)	97.0 (9.4)	98.2 (9.7)	96.4 (9.3)	0.160
Waist-to-hip ratio	0.74 (0.06)	0.79 (0.05)	0.72 (0.06)	<0.001***
Resting heart rate (bpm)	79 (12)	75 (12)	81 (12)	<0.001***
SBP (mmHg)	122 (13)	131 (13)	118 (11)	<0.001***
DBP (mmHg)	71 (10)	71 (12)	71 (10)	0.981
Random blood glucose (mmol/L)	5.0 (1.1)	5.1 (1.1)	5.0 (1.1)	0.368
RTC (mmol/L)	3.9 (0.9)	3.4 (0.8)	4.1 (0.9)	<0.001***
AUDIT score	2.8 (3.6)	3.9 (4.1)	2.3 (3.2)	0.001**
Kasari FIT Index score	31.7 (27.1)	36.9 29.9)	29.4 (25.7)	0.043*
REAP-S score	27.4 (4.7)	26.6 (4.5)	27.7 (4.8)	0.101
PSQI Sleep score	6.7 (2.8)	6.4 (2.9)	6.9 (2.7)	0.251

*p<0.05
**p<0.01
***p<0.001
BMI = body mass index; SBP = systolic blood pressure; DBP = diastolic blood pressure; RTC = random total cholesterol; AUDIT = Alcohol Use Disorder Identification Test; REAP-S = Rapid Eating Assessment for Participants – short version; PSQI = Pittsburgh Sleep Quality Index.

high prevalence to inform the development of lifestyle interventions in the SA context. SA's current 5-year strategic plan focuses on implementing a cascading model for NCDs, similar to the 90-90-90 framework model for HIV and TB.[24] The present study revealed that 33.9% of the students had suspected hypertension, a condition many were likely unaware they had. This is much higher than the Strategic plan indicator, which advises that 90% of the population should know their NCD status.

A limitation of this study is that all behavioural risk factors were self-reported using online questionnaires. These questionnaires are recognised as reliable tools, but objective measurements are acknowledged as being more robust. A second limitation was that blood cholesterol and glucose assessments were not analysed based on a venous blood sample after an overnight fast. However, random total cholesterol has been shown to be a valid marker of blood lipid levels as advised by the WHO,[25] and guidelines exist for random glucose levels.[16] A third limitation was that blood pressure measurements were not repeated on different occasions. A strength of this study was that all metabolic risk assessments were objectively measured by trained staff, unlike other similar studies.

Conclusion

This study showed a high prevalence of lifestyle related NCD risk factors among first-year medical students. Almost eight in ten medical students reported poor sleep quality and two-thirds reported low-to-moderate diet quality and insufficient levels of habitual physical activity. About one-third had elevated blood pressure. Poorer lifestyle habits and metabolic profiles were more evident in the male sub-group and more than 80% of the whole cohort had two or more risk factors. The results of this research have provided valuable insights into specific health behaviours that warrant attention in this group of university students, who are at the beginning of their journey to becoming healthcare professionals. As students learn about the risk factors associated with lifestyle-related diseases through curriculum content, lectures and practical sessions, they will improve their clinical knowledge of the prevention and treatment modalities related to lifestyle diseases. It is anticipated from this research that creating awareness of their own health will encourage medical students to adopt healthy behaviours and consequently counsel their future patients on healthy lifestyles. Universities allocate significant resources to supporting the wellbeing of students. This research will assist in identifying the required interventions, the appropriate allocation of resources and the development of programmes to improve the health and academic performance of students. These are important strategies to complement educators' efforts in producing competent and skilled healthcare professionals who can provide high-quality care and contribute to the improvement of health outcomes in their communities.

It is recommended that future research focus on sleep quality and assess measured fitness parameters as they compare with self-reported physical activity behaviour. Furthermore, studies should explore the evolution of lifestyle behaviours throughout the academic programme, to determine the impact of health knowledge gained through the course of a medical degree. In this way, longitudinal studies related to the current research may contribute to educational strategies focused on NCD-related risk factors and lifestyle interventions through the course of medical degrees.

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Author contributions. JB, MB and MPS contributed to the study conception. JB, MB, PW, TC, KN, MS, DB and MPS contributed to the methodology and data

collection. BC contributed to data curation, and BC, JB and MPS contributed to writing the original draft. RL provided formal analysis and data curation. All authors contributed to the writing, review and editing of the manuscript.

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Data availability statement. The datasets generated and analysed during the current study will be made available upon reasonable request.

Conflicts of interest. None.

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