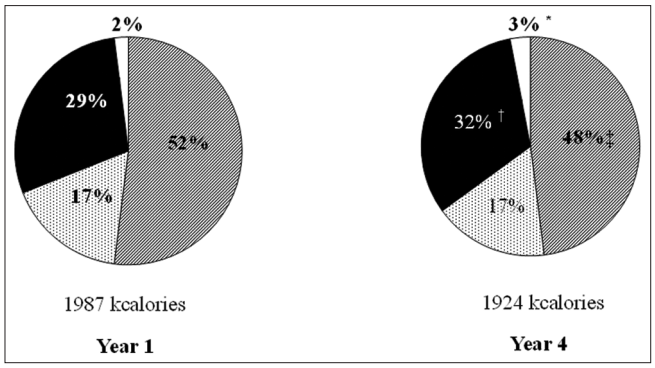

Figure 3: Mean caloric intake and distribution of macronutrients (as percentage of total kilocalories) of participants during year 1 and year 4 of medical school. *$P = 0.02$, change from year 1 to year 4; †$P < 0.01$, change from year 1 to year 4; ‡$P < 0.001$, change from year 1 to year 4. Stripes represent carbohydrate; dots represent protein; solid black represents fat; solid white represents alcohol

participants with blood pressure levels indicating hypertension. Still, 18.5% (18/97) of the study population in year 4 exhibited prehypertension, which is having systolic blood pressure between 120 and 139 mmHg or diastolic blood pressure between 80 and 89 mmHg. Elevated fasting insulin indicates insulin resistance, a risk factor for diabetes and cardiovascular disease. Although insulin levels increased significantly during the study period, mean fasting insulin values in both year 1 and year 4 were within the reference range.[28] However, in year 4, 10 participants had insulin levels exceeding 25 μU/mL. Mean levels of HDL-cholesterol among participants were higher than the adult average[37] and increased over the course of medical school. Lifestyle modification associated with increased HDL-cholesterol includes frequent aerobic activities. Interestingly, participants reported an increase in their physical activity during medical school, which may have been influenced by the opening of a fitness center within the medical college mid-way through the study period.

In our study, participants reported lifestyle habits congruent with national recommendations. Prior research has indicated that medical students report higher physical activity levels than age-matched peers in the general population.[9] However, a recent longitudinal study using objective measures of physical fitness among medical students at the Uniformed Services University showed that muscular endurance and aerobic capacity declined during medical school.[38] Our results concurred with these studies, showing a trend toward declining physical fitness during medical school, despite a reported increase in physical activity.

While college students often adopt unhealthy eating habits related to factors such as stress and lack of time, a recent study of Malaysian medical students by Ganasegeran *et al*.[39] suggested that most medical students consume relatively healthy diets that meet national dietary guidelines. Similarly, our findings showed that participants' intake of carbohydrate, protein, and fat was within the acceptable macronutrient distribution ranges, intake of most micronutrients met DRI recommendations, and HEI scores were indicative of a relatively high-quality diet in both years 1 and 4.

Despite the overall quality of the participants' diets, a few concerns were noted. With the increasing awareness of the essential role of Vitamin D in preventing osteoporosis and the common occurrence of insufficient Vitamin D status in the US, it is not surprising that Vitamin D intake increased during the study, particularly among females. Yet, the mean Vitamin D intake was below the current recommendation of 600 IU/day for both males and females throughout medical school. Similarly, some students may have been motivated to restrict sodium intake due to an emphasis on lowering dietary sodium for the prevention and treatment of hypertension. However, the average sodium intake of all participants remained higher than the American Heart Association recommendation of 1500-2300 mg/day. The role of trans fat in the promotion of cardiovascular disease led the National Heart, Lung, and Blood Institute and the American Heart Association to recommend consuming as little trans fat as possible. Yet, intake of trans fat, found primarily in convenience and processed foods, increased among males during the study period.

In a longitudinal survey of US medical students by Frank *et al*.,[10] almost all students (97%) categorized their health as good, very good, or excellent, with a median of 1 day of poor physical health in the past month. Women reported significantly more days of poor mental health at the end of medical school (i.e. an increase from 1 to 2 days per month), while men reported no days of poor mental health at the start and finish of medical school. Our study results support the prior study's notion that medical students rate their health highly with very little occurrence of poor physical health. However, in our study, both males and females reported a higher frequency of poor mental health (median of 3 days per month) throughout medical school, perhaps related to multiple stressors such as academic challenges, financial concerns, or life events.[11,12]

The results of several research studies suggest that the integration of nutrition and physical activity topics throughout the curriculum's didactic and clinical components is needed to positively influence students' knowledge and behaviors.[4,40,41] During the study, in years 1 and 2 of medical school, the College's Clinical Foundations courses included nutrition lectures that were delivered by physicians and dietitians. The lecturers addressed dietary guidelines for disease prevention and nutrition therapy for several medical conditions, such as cardiovascular disease, diabetes, obesity, and critical illness. During the 3rd year clerkships, teaching strategies included lectures, case studies, online learning modules, and clinical experiences that addressed clinical nutrition. In addition, optional nutrition-related learning experiences were available to students. Clinical Nutrition, a 2-week elective course, was offered to 4th year students. The Medical Student Scholars Program – Nutrition Pathway was a longitudinal program that

offered nutrition-related extracurricular educational, clinical and research experiences to selected members who were admitted as 1st year students.

Limitations

There are inherent limitations to our study. Since all participants were recruited from one medical school, generalizability of results is limited to similar institutions. Enrollment in the study was voluntary and limited; therefore, study participants may not represent our medical student population in terms of health status or lifestyle habits. While we assessed alcohol consumption as part of the overall diet analysis, we did not collect further data on factors such as alcohol consumption patterns, smoking, or other coping behaviors which may have provided more insight into the participants' health. The longitudinal design and objective measurement of clinical parameters by trained health professionals following specific protocols are strengths of the study. Controversy remains over whether medical school does or does not affect the health status of students. Therefore, future longitudinal studies using similar clinical measures are needed with larger samples of medical students from several universities.

Conclusions

To the best of our knowledge, this is the first longitudinal study that assessed anthropometric and metabolic measures and lifestyle behaviors of medical students. Overall, our findings suggest that students' health and habits do not decline over the course of medical school; yet some students exhibit at-risk clinical measures, as well as diet and activity behaviors that are not aligned with national recommendations.

Prior research has shown that the health practices of medical students and physicians have the potential to play a highly influential role in counseling patients about disease prevention. Those who engage in healthy lifestyles are more likely to serve as role models and to provide quality counseling on exercise, diet, smoking, and other practices.[4,42] Integration of the behavioral and social components of health (e.g., diet and physical activity) throughout medical school curricula has been recommended for over a decade by the Institute of Medicine[43] and others.[7,8] At the time of the study, the College of Medicine's inclusion of nutrition-related lectures, case studies, online modules, and clinical experiences throughout the curriculum and the addition of a fitness center are noteworthy. Such curricular initiatives that address essential lifestyle practices may be the first step in enhancing students' self-awareness, self-efficacy, and motivation to model healthy behaviors for their patients.[40,42] Moreover, integration of behavioral counseling into the curriculum's didactic and experiential components may advance students' skills to engage in preventive counseling. Ultimately, such educational efforts may lead to healthier lifestyle habits and positive health outcomes for future physicians and their patients.

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Conflicts of interest

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