

Inappropriate nutrition leads to an energy deficit in medical students during 24-hour shifts.

El gasto calórico conduce a un déficit energético en estudiantes de medicina en un turno de 24 horas.

Eduardo Flores-Villalba^{1, 2, *}, Jose I Ortiz De Elguea-Lizarraga², Victor Segura-Ibarra^{1, 2}, Elvia M Dominguez-Barragan², Ana S Guerra-Cantu², Jose A Diaz-Elizondo², Marisa G. Frausto-Alejos², Dixia Ramirez¹

1. TEC de Monterrey, School of Engineering and Science, Department of Advance Manufacturing, Monterrey, México
2. TEC de Monterrey, School of Medicine and Health Sciences, Department of Clinical Research, Monterrey, México

***Corresponding author:** Eduardo Flores-Villalba, MD, MSc
TEC de Monterrey, School of Medicine and Health Sciences
Ignacio Morones Prieto 3000 Pte. Col. Doctores Monterrey, NL., México, CP 64710
Email: eduardofloresvillalba@tec.mx
Phone: 52 (81) 88 88 03 10

DOI <http://dx.doi.org/10.28960/revmeduas.2007-8013.v11.n4.003>

Recibido 01 de Julio 2021, aceptado 28 de Julio 2021

Abstract

Introduction: Surgical rotations of medical students are physically, emotionally, and intellectually demanding. Energy expenditure throughout a shift, lack of sleep and inadequate nutrition affect student's performance. **Objective:** The aim of this study is to describe and analyze caloric intake and energy expenditure during a 24-hour shift in medical students during a clinical surgical rotation. **Materials and Methods:** Twenty-three medical students wore a smart armband during a 24-hour shift to register energy expenditure physical activity, along reports of meals and food intake. **Results:** Median energetic expenditure was of 3666 kcal/day while intake was of 1384 kcal/day, averaging a deficit of 2374 kcal. Students slept a median of 0 minutes and walked 9252 steps. **Discussion and Conclusion:** These parameters should be considered when designing clinical rotations to provide quality service to patients and ensure the well-being of students.

Key words: Caloric expenditure, medical students, Shifts, Clinical Internship

Resumen

Introducción: Las rotaciones clínicas de cirugía de los estudiantes de medicina son exigentes física, emocional e intelectualmente. El extraordinario gasto de energía que se tiene durante un turno quirúrgico, la falta de sueño y una nutrición inadecuada, afecta a los estudiantes de manera profesional y en su vida personal. **Objetivo:** Describir y analizar la ingesta calórica y el gasto energético durante un turno de 24 horas en estudiantes de medicina durante una rotación clínica de cirugía. **Materiales y métodos:** Veintitrés estudiantes de medicina usaron un brazalete inteligente durante un turno de 24 horas con el fin de obtener el gasto de energía, horas de sueño y actividad. Los estudiantes también reportaron cada comida e ingesta de alimentos durante su turno. **Resultados:** La mediana del gasto energético fue de 3666 kcal/día y la mediana de ingesta fue de 1384 kcal/día, lo que llevó a un déficit calórico de 2374 kcal. Los estudiantes durmieron una mediana de 0 minutos y caminaron 9252 pasos. **Discusión y conclusión:** Estos parámetros deben ser considerados al diseñar rotaciones clínicas para brindar un servicio de calidad a los pacientes y asegurar el bienestar de los estudiantes.

Palabras clave: Gasto calórico, estudiantes de medicina, turno, pasantías clínicas.

Introduction

College students have a poor quality diet due to many factors: living away from home, scarce time dedicated to quality food preparation and other behavioral factors¹. Medical students un-

dergo excessive stress during their clinical rotations, which is another factor that greatly impacts their diets and eating habits. The typical 24-hour shift of medical students during a surgical clinical rotation consists of long periods that

are physically, emotionally and intellectually demanding. Student's tasks during their surgical shifts include wound cleaning, nasogastric tube placement, urinary catheter placement, medical history taking, and writing notes, between other activities. They are also frequently encountered with complex questions, which require continuous study and research during the shift. Most of the time, these shifts are so busy that medical students have little or no opportunity to sleep or eat, and when they do, it is usually poor-quality rest and meals²⁻⁴.

According to the Institute of Medicine, a regular diet should have 45-65% carbohydrates, 20-35% fat, and 10-35% protein⁵. When medical students have a chance to eat, they usually rely on fast food due to the short amount of time they can dedicate to this important aspect. Fast food is high in fats and carbohydrates but low in proteins and other micronutrients⁶.

On the other hand, sleep deprivation has been associated with decreased leptin levels and increased ghrelin levels which result in increased hunger⁷. Therefore, sleep deprivation can be directly linked with increased caloric intake and a positive nutritional balance.

Medical students are having a bad diet in terms of quantity and quality. Poor diets are associated with chronic health problems in the future like diabetes mellitus, hypertension, and even oncological problems⁸.

The aim of this study is to describe and analyze caloric intake and energy expenditure during a 24-hour shift in medical students during a clinical surgical rotation. We also measured the steps they took during the shift, total time of sleep, and the total time of activity.

Materials and Methods

Prior informed consent, twenty-three medical students from TEC de Monterrey School of Medicine were enrolled from February to April 2015 during their surgical clinical rotation of 3 months at a public hospital in Monterrey, Mexico to participate in this survey.

Enrolled participants were weighted and measured the day before their shift. Students wore a SenseWear™/Armband (SWA) (BodyMedia, Inc. Pittsburgh, PA) during a 24-hour shift in order to attain energy expenditure, hours of sleep, and activity. Even though students usually stayed at the hospital for 32 hours, only the first 24 hours were analyzed from 7:00 am to the next day. Energy expenditure, sleep hours, and activity was estimated from the SWA proprietary equations developed by the manufacturer. Students sent pictures from every meal and food intake in real time via cell phone to our team. Portions from each meal were calculated according to Mexican National System of Food Equivalents (Sistema Nacional de Alimentos Equivalentes) (8). Most of the food intake (approximately 80%) was wrapped or canned food, so calorie intake was obtained from the label.

Data was analyzed using SPSS® (Chicago II, version 22) and expressed as medians and Interquartile ranges (IQR). Further analyses were performed using U-Mann Withney to compare among groups, $p < 0.05$ was considered as significant.

Results

We analyzed 23 medical students, 10 (43.47%) males and 13 (56.52%) females. All of which concluded the study. The median height and weight was 171 cm and 71 kg. Median body mass index (BMI) was 25 kg/m². We found a significant difference in weight ($p < .001$) and height ($p < .000$) between males and females. The median energetic expenditure was 3666 kcal/day and the median intake was of 1384

kcal/day, leading to a caloric deficit of 2374 kcal. (Table 1).

The medical students in our group had a median intake of 46% of carbohydrates, 38% of fat, and 16% of protein. We found that female students had a lower intake of proteins than male students with a significant ($p < .049$) difference (Table 2).

Medical students walked a median of 9252 steps during the 24-hour shift, which is equivalent to 166 minutes of continuous activity and they slept a median of 0 zero minutes (IQR 0-53) minutes in 24 hours with. (Table 3).

Table 1: Demographics and energy balance of enrolled participants during a 24-hour shift.

Variables	Total (n=23) Median (IQR)	Male (n=10) Median (IQR)	Female (n=13) Median (IQR)	p*
Age	23 (22-24)	23 (21-24)	23 (21-24)	ns
Weight (kgs)	70 (56-91)	89 (77-95)	61 (54-74)	.001
Height (cms)	172 (160-180)	181 (177-184)	160 (157-171)	.000
BMI	25 (22-28)	27 (23-29)	23 (20-26)	ns
Energetic Expenditure	3666 (3001-4435)	3969 (2907-4429)	3580 (3004-4744)	ns
Intake	1384 (1002-1599)	1299 (984-1822)	1384 (1003-1582)	ns
Caloric Deficit	2374 (1272-3355)	2588 (773-3408)	2250 (1350-3325)	Ns

Results are expressed as median and IQR

BMI = Body mass index; Ns= not significant, IQR= Interquartile ranges, *Comparison between males and females; $p < 0.05$ was considered significant

Table 2: Total and relative macronutrient intake of enrolled participants during a 24-hour shift.

Variables	Total (n=23) Median (IQR)	Male (n=10) Median (IQR)	Female (n=13) Median (IQR)	p*
Protein Grams %	61 (31-91)	87 (53-122)	40 (29-73)	049
	16% (11-20)	20 (18-25)	36 (29-46)	.021
Carbohydrates Grams %	157 (116-194)	158 (120-215)	147 (97-185)	ns
	46% (41-56)	45 (39-52)	49 (41-58)	ns
Fats Grams %	50 (39-90)	61 (45-105)	48 (35-82)	ns
	38% (30-46)	38 (33-44)	36 (29-46)	ns

Results are expressed as median and IQR; Ns= not significant; IQR= Interquartile ranges

*Comparison between males and females

p<0.05 was considered significant

Table 3: Minutes of physical activity, sleep, and total steps of enrolled participants during a 24-hour shift.

Variables	Total (n=23) Median (IQR)	Male (n=10) Median (IQR)	Female (n=13) Median (IQR)	p*
Activity (min)	166 (90-225)	137 (98-212)	202 (90-346)	ns
Sleep time (min)	0 (0-53)	19 (0-115)	0 (0-15)	ns
Steps	9252 (3190-11953)	8537 (2955-12551)	9252 (4295-11563)	ns

Results are expressed as median and IQR

Ns= not significant; IQR= Interquartile ranges

*Comparison between males and females

p<0.05 was considered significant

Discussion

Evidence suggests that college students have a poor-quality diet. Based on a diet quality index, it has been described that 77% of students need to improve their diet and that 21% had a very poor quality diet⁹. Poor quality diet in college has been associated to similar dietetic behaviors in adulthood, which represents a major risk factor for chronic degenerative diseases and even oncologic diseases, as mentioned previously¹⁰.

According to the Dietary Guidelines for Americans 2010, college students should receive from 1800 to 2400 Kcal per day for women and from 2400 to 3000 Kcal for men¹¹. In our study we found an average consumption of 1,458.45 kcal/day for males and 1350.18 kcal/day for females, approximately 1000 kcal/day less than previous reports. Moreover, our students met the definition of a hypo caloric diet even in a sedentary group.

In our study we measured the quantity of kcal consumed per day along with the energy expenditure, sleep time and activity during a 24-hour shift, enabling the calculation of a nutritional balance.

We found that in average, medical students had an energy expenditure of 3,833.83 kcal/day, resulting in an average negative balance of 2,436.57 kcal/day, which is twice the amount of calories an average 140 pounds person should spend. Surprisingly, one of our medical students had an energy expenditure of 6,833 kcal/day, which is in the realm of high performance athletes during intense training which have an energy expenditure from 4,200 to 7000 kcal¹¹.

Participants walked an average of 8,712 steps, the corresponding to walking approximately 4 kilometers and the equivalent to an average of 185 minutes of registered continuous activity.

Students at our program as well as most in many countries, run under an 80-hour per week program with 24-hour shifts every second day. During weekdays, they stay at the hospital for 8 more hours after their shift with a total of 32 hours average, and the day before their shift they work for 8 to 10 hours during daytime. Weekend shifts last 24 hours as well but they do not stay afterwards and if they are not on call, they do not attend clinical duties. According to our data, this means that at least 2 to 3 days a week, a medical student will spend twice the energy they consume. Wishnofsky's rule states

that 3,500 kcal are equivalent to 1 pound of weight mass¹². Using this rule, we can estimate that our students loose in average two pounds per week during their surgery clinical rotation.

As mentioned before, the problem is not entirely the caloric deficit that medical students are currently having. Even a normal caloric diet or a hyper caloric diet might lead to nutritional deficit due to the bad quality of the food ingested. Food with a large percentage of fat will supply the calories necessary but not all the nutriments and therefore will also lead to health problems at a long term. As mentioned previously, a regular diet for people from 19 to 30 years old should be divided in 45-65% carbohydrates, 20-35% fat, and 10-35% protein (5). Therefore, our group had a slightly high percentage of fat and a normal distribution of carbohydrates and proteins in their shifts with the inconvenience that 80% of food was wrapped or canned.

It is very important to state that nutritional deficiency is associated with many health problems. Micronutrient deficiency is associated with bad functioning of the immune system, predisposing to infectious diseases, which are currently encountered by medical students in a typical surgical shift¹³.

Even though it was not measured in this study, micronutrients deficit such as iron, zinc, calcium, iodine, copper, selenium, vitamin E, and folic acid has also been described in college students. From these, calcium is one of the most

important nutrients during youth; it is underprovided in 53% of students and has serious repercussions on bone health leading to osteopenia and osteoporosis ¹⁴.

Sleep deprivation decreases retention of information, information processing, and decreases learning motivation. It has been reported that medical students with sleep deprivation describe themselves as inattentive ¹⁵. In our group, medical students slept an average of 43.43 minutes per shift.

To the best of our knowledge, this is the first study in which a nutritional balance between calorie intake and energy expenditure, sleep hours and activity is presented during a 24-hour shift in medical students. This might also be an attention call to the development of wellness programs in medical students with long-work hours, reduced sleep, intense activity and poor nutrition. Our group at Tec of Monterrey, has been working in the diagnosis of our students physical and mental health and has proposed programs and adequations to overcome these situations, such as implementing personal tutoring, more effective learning scenarios (which leads to less clinical hours needed), meal quality improvement, psychological support, wellness center, recreating activities and learning communities among others.

One of our study limitations is that students were responsible to send pictures of the food intake

during their shift, and even though ethical behavior is one of our institutional values, instructions were very clear, and a compromise agreement was signed by each participant, we are aware that information might have been manipulated or missing. Another drawback from our study is the small sample, but we believe this novel study would serve as reference to further research.

We are also aware that the photographic method for assessment of dietary quality is currently the method used for calorie intake measurement. Due to the complexity of medical interns' shifts we were not able to apply this method, so we calculated calorie intake by using pictures recollected by mobile devices and estimating calories according to the portions from "Sistema Nacional de Alimentos Equivalentes"¹⁶. Despite this, canned or wrapped food represented 80% of the ingested calories in our study.

Conclusions

There is an important caloric deficit in medical students during surgical 24-hour shifts, additionally sleep deprivation is an important concern that must be elucidated in further studies. Strategies must be implemented to improve the quality and quantity of food consumed by medical students during their surgery rotations.

Declarations

Ethics approval and consent to participate

This study was performed under the standards provided by the Declaration of Helsinki, safeguarding the rights and wellbeing of the participants in the survey. This survey was performed to document with scientific data the conditions in which medical students perform their rotations to incentivize positive changes in their clinical environment. All participants were volunteers and posterior to a fully detailed explanation, signed an informed agreement. Those who did not desired to participate continued their normal activities without any repercussion in their academic environment.

Prior to the realization of this survey, the Institutional Ethics Committee deemed that this study did not require a protocol submission. This was agreed given the observational nature of the design and thus, waived. Secondary studies that include interventions within the design will require a full protocol submission.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

This study was performed with internal funding from the Department of Advance Manufacturing and the Department of Clinical Research.

Authors' contributions

E.F.V. and **D.R.** designed and supervised the study. **E.M.D.B.**, **A.S.G.C.**, **D.R.** and **J.A.D.E.**, validated the methodology and results. **J.I.O.E.L.**, **V.S.I.** y **M.G.F.A** Analyzed the results and wrote the manuscript. All of the authors agree for the publication of this manuscript.

Acknowledgements

The authors would like to thank all the volunteers that decided to participate in the survey for this manuscript. We thank the department of Advance Manufacturing for providing the arm-bands for this study.

References

1. Truswell AS, Darnton-Hill I. Food habits of adolescents. *Nutr Rev.* 1981;39(2):73-88.
2. Winston J, Johnson C, Wilson S. Barriers to healthy eating by National Health Service (NHS) hospital doctors in the hospital setting: results of a cross-sectional survey. *BMC Res Notes.* 2008;1:69.

3. Dahlin ME, Runeson B. Burnout and psychiatric morbidity among medical students entering clinical training: a three year prospective questionnaire and interview-based study. *BMC Med Educ.* 2007;7:6.
4. Dyrbye LN, Massie FS, Eacker A, Harper W, Power D, Durning SJ, et al. Relationship between burnout and professional conduct and attitudes among US medical students. *JAMA.* 2010;304(11):1173-80.
5. Acheson KJ. Carbohydrate for weight and metabolic control: where do we stand? *Nutrition.* 2010;26(2):141-5.
6. Bowman SA, Vinyard BT. Fast food consumption of U.S. adults: impact on energy and nutrient intakes and overweight status. *J Am Coll Nutr.* 2004;23(2):163-8.
7. Spiegel K, Tasali E, Penev P, Van Cauter E. Brief communication: Sleep curtailment in healthy young men is associated with decreased leptin levels, elevated ghrelin levels, and increased hunger and appetite. *Ann Intern Med.* 2004;141(11):846-50.
8. Bidlack WR. Interrelationships of food, nutrition, diet and health: the National Association of State Universities and Land Grant Colleges White Paper. *J Am Coll Nutr.* 1996;15(5):422-33.
9. Guo X, Warden BA, Paeratakul S, Bray GA. Healthy Eating Index and obesity. *Eur J Clin Nutr.* 2004;58(12):1580-6.
10. Kant AK, Schatzkin A, Ziegler RG. Dietary diversity and subsequent cause-specific mortality in the NHANES I epidemiologic follow-up study. *J Am Coll Nutr.* 1995;14(3):233-8.
11. Cluskey M, Grobe D. College weight gain and behavior transitions: male and female differences. *J Am Diet Assoc.* 2009;109(2):325-9.
12. Thomas DM, Gonzalez MC, Pereira AZ, Redman LM, Heymsfield SB. Time to correctly predict the amount of weight loss with dieting. *J Acad Nutr Diet.* 2014;114(6):857-61.
13. Maggini S, Pierre A, Calder PC. Immune Function and Micronutrient Requirements Change over the Life Course. *Nutrients.* 2018;10(10).
14. Fitzpatrick LA. Secondary causes of osteoporosis. *Mayo Clin Proc.* 2002;77(5):453-68.
15. Browne BJ, Van Susteren T, Onsager DR, Simpson D, Salaymeh B, Condon RE. Influence of sleep deprivation on learning among surgical house staff and medical students. *Surgery.* 1994;115(5):604-10.
16. Lieffers JR, Hanning RM. Dietary assessment and self-monitoring with nutrition applications for mobile devices. *Can J Diet Pract Res.* 2012;73(3):e253-60.