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Articles

Metabolic Profile of Medical Students Before and After Work Shifts at Roosevelt, San Juan de Dios, Regional de Cuilapa, Escuintla and Nacional de Antigua Hospitals

Perfil Metabólico de estudiantes de medicina antes y después de turno en los hospitales Roosevelt, San Juan de Dios, Regional de Cuilapa, Regional de Escuintla y Nacional de Antigua

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Abstract: The long work shifts of 16 and 24 hours and up to 32 to 36 hours that

doctors have in the hospital, exert a negative effect on their physical and emotional health. Alterations have been described in the levels of glycaemia, catecholamines, cortisol, heart rate, among others. This research aimed to compare the metabolic profile of internal and external medical students of the Faculty of Medical Sciences of the University of San Carlos de Guatemala, before and after their hospital shifts. This paired study was carried out in many national hospitals, such as: Hospital Nacional Roosevelt, Hospital General San Juan de Dios, Hospital Regional Cuilapa, Hospital Regional de Escuintla and Hospital Nacional de Antigua. Glycaemia, lipid profile and cortisol; vital sings, and lifestyles before and after shifts were evaluated in 80 students. Significant variation was observed in cortisol values (p = .023), glycaemia (p = .002) y triglycerides (p = .050) before and after the work shift. After the work shift the student experienced an increase in cortisol values and a decrease in glycaemia and triglyceride levels. These changes were associated to the different hospitals.

Keywords: hydrocortisone, physiological stress, blood glucose, Medical students.

Resumen: *Las largas jornadas laborales a las que se someten los médicos en el contexto hospitalario, ejercen un efecto negativo sobre su estado físico y emocional, abarcando hasta 16 a 24 h al día y hasta 32 a 36 h continuas sin descanso. A nivel de pruebas de laboratorio y signos clínicos, se han descrito alteraciones en los niveles de glicemia, catecolaminas, cortisol, frecuencia cardiaca, entre otros. El objetivo fue comparar el perfil metabólico en los estudiantes externos e internos de la Facultad de Ciencias Médicas de la Universidad de San Carlos de Guatemala, antes y después del turno hospitalario. Este estudio apareado se realizó en los hospitales Roosevelt, San Juan, Regional de Cuilapa, Regional de Escuintla y Nacional de Antigua, evaluándose la glicemia, el perfil lipídico y el cortisol; signos vitales y estilos de vida antes y después de turno en 80 estudiantes. Se observó variación significativa en los valores de cortisol (p = .023), glicemia (p = .002) y triglicéridos (p = .050) antes y después del turno). Se concluyó que después del turno el estudiante experimentó aumento en los valores de cortisol y disminución en los niveles de glicemia y triglicéridos; estos cambios no se asociaron al grado académico, a sexo ni a servicio hospitalario, pero sí al hospital.*

Palabras clave: *hidrocortisona, estrés fisiológico, glucemia, estudiantes de Medicina*

Introduction

Work shifts, which is defined as the accumulation of hours that go from 16 to 24 hours per day by means of work of various successive groups of people, cause alterations in circadian and social cycles. Among the various effects of these alterations, we can find: decrease in the metabolic rate in rest, increase in serum glucose levels, lower work satisfaction, accumulation of fatigue due to sleep deficiency, inability to act quickly, difficulty at paying attention and perceiving information correctly, decrease in movements precision, long term diabetes and obesity, and overall, poor performance (especially during 3 and 6 a.m.) (Darcia, 2016; Buxton *et al*., 2012).

In addition, we know from Moore and contributors that chronic interruptions in circadian rhythm are associated to a higher risk of suffering sleep-wake disorders, gastrointestinal and cardiovascular problems (Moore-

Ede & Richardson, 1985; Smith-Coggins, Rosekind, Buccino, Dingers, & Moser, 1997).

We can deduce that health care quality would be affected if the health providers work for long shifts in uninterrupted manner. Waterhouse reported since 1994 that young doctors that worked from 36 to 48 hours might make mistake due to fatigue (Waterhouse & Dphil, 1999).

Due to this situation, this topic has been addressed in different ways: the Accreditation Council for Graduate Medical Education, in the United States, is an example of the interest in implementing a resting time after a work shift, limiting the work hours up to 16 hours of uninterrupted labor, with a minimum of 8 hours out of service for resident doctors (Nasca, Day, & Amis, 2010).

In Spain, resident medical interns (MIR, Spanish acronym for *Médicos Internos Residentes*) belonging to 14 communities and representatives of 25 European countries, in 2007, implemented the campaign "*Llevo 32 horas sin dormer, ¿te opero?*" (I have been awake for 32 hours. Do you need a surgery?). This aimed to decrease weekly work hours of 70-80 hours, as well as the work shift of 32 hours without rest. They tried to implement a resting period of 24 hours after every shift (Santos, 2007).

In Guatemala, students of the fourth, fifth and sixth year of medicine, and the residents of medical specializations work day shifts of around 10 hours, from 6:30 a. m. to 4:30 p. m., Monday through Friday. Once or twice a week, they are assigned to a mixed shift (day and night), from 4:00 p. m. to 8:00 a. m. That is a shift of about 16 hours. Frequently, mixed shifts occur along with day shifts, ending up in a work shift of 36 hours. Doctors do not have a pre-established schedule for personal hygiene or food time. This way, in the majority of the times, the General Normative of External and Internal Students is not fulfilled (Mazariegos & Herrera, 2009).

Aiming to contribute to the improvement of work condition for medical staff, and so the quality of the health care service, in this study, we strive to determine the alterations in the metabolic profile before and after work shifts in school hospitals: Roosevelt, San Juan de Dios, Regional de Cuilapa, Regional de Escuintla, Nacional Pedro Bethancourt.

Materials and Methods

Research Scheme

The scheme of the study was a paired measurement scheme. The reference population is the pre-graduate students of the fourth, fifth, and sixth year of Medicine of the Faculty of Medical Sciences of the University of San Carlos de Guatemala, who had their hospital internship in Roosevelt, San Juan de Dios, Regional de Cuilapa, Regional de Escuintla and Nacional de Antigua Hospitals, in the departments of Internal Medicine, Surgery, Obstetrics and Gynecology, and Pediatrics, February to May, 2016.

Sampling Scheme

To calc ulate the size of the sample, a pilot convenience sample was carried out with 30 students, where the levels of cortisol were taken. The mean (standard deviation) of the differences before and after was 14.5 (55.1) units, and the size of the effect, according to d of Cohen = 0.263.

The definite size of the sample was calculated based on the results of the pilot test, using the software G*Power 3.1.9.2. The chosen method was the Wilcoxon signed-rank test for paired means, a significance level of 5% and a power of 80 % were assigned. The chosen distribution was Laplace (due to the high dispersion) and a bilateral test- The calculated size of the sample was 77 people.

The selection of the participants was a convenience selection. Based on a sampling frame provided by the Faculty of Medical Sciences, the sample was stratified proportionally according to the number of internal and external students, year of study, and assigned hospital.

Selection Criteria

Inclusion Criteria: Students from the fourth, fifth, and sixth year of the Faculty of Medical Sciences of the University of San Carlos de Guatemala, who were in their work shift in the aforementioned hospitals during the moths of February to May, 2016, that had previously signed an informative consent.

Exclusion Criteria: Students with any metabolic disorder, previously diagnosed, students with treatment for any acute infection (dengue fever, pharyngotonsillitis, cold, etc.), students that had had a recent surgery.

Processing and Analysis of the Data:

The data was tabulated into a data base in Excel. The analysis of the data was carried out the free-distribution software, R version 3.3.

The probability distribution of the differences of biochemical variables before and after work shift, using a Shapiro-Wilk test, with a significance of 5%. The numerical parametric data was summarized with a standard mean and deviation; the non-parametric data, with a median and an interquartile range. To assess the changes in quantitative variables before and after work shifts, the *t*-test of paired sample and the Wilcoxon signed-rank test were used, depending on the probability distribution of the variable.

The responses of quantitative variables (glycaemia, triglycerides, cortisol, etc.) according to academic year, sex and hospital, using the Wilcoxon rank.-sum test and the Kruskal-Wallis test, respectively in cases of non-parametric variables and their parametric equivalents, Student's *t* and analysis of variance.

Techniques, Procedure, and Instruments Used in Data Collection

The hospitals in the matter were visited a day before the sample taking in order to inform about the study. We proceeded to fill the data collection instrument with the information that the students provided. We did the same procedure the day after the work shift, taking notes of the vital signs of the students (blood pressure, heart rate, breathing rate and body temperature). We took blood samples, which were processed in the clinical laboratory of

the Faculty of Medical Sciences. The samples were transported in a RCW-25 Electrolux towards the Faculty of Medical Sciences of the University of San Carlos de Guatemala.

Biochemical Analysis of the Samples

One technique and four researcher were in charge on the analysis of the samples. They verified the correlation of the of the students identification number with the data collection sheet. The sample was centrifuge in a Centra MP 4R at 3000 revolutions per minute (RPM) for 5 minutes; after this, the sample was considered ready to be processed. At least 500 µl of the sample without cells were transferred to an Eppendorf tube of conservation for the cortisol test. Right after this, it was closed. The samples were preserved locked hermetically. Since the test was not carried out until 48 hours later, the samples were frozen at -20 °C. For the triglycerides and blood sugar test, we used 10 µl of serum and 1 µl of reagent for triglycerides and blood sugar, respectively. These being from DIALAB and measured with a micropipette from Bio-Rad. The sample was incubated for 20 minutes before being read. After this, the sample was placed in a RIELE 5010 photometer 5010, which helped to get the results. For the cholesterol test, we used 10 µl of serum and 1 µl of reagent respectively. These being from DIALAB and measured with a micropipette from Bio-Rad. The sample was incubated for 20 minutes before being read. After this, it was placed in a RIELE 5010 photometer 5010, which helped to get the results. For the collection and preparation of the HDL sample, we avoid using hemolysis of the sample. It was pipetted, shaken, and then left aside for 10 minutes at room temperature. It was centrifuged for 10 minutes at 4 RPM, taking carefully from it the supernatant. Before being incubated for 30 minutes at room temperature (16-25 °C), the tubes were shaken. After this, we read the absorbance of the pattern and the sample at 500 nm in front of the empty tube. For the LDL test, the results of triglycerides, cholesterol and HDL were used with the following formula: cholesterol – triglycerides/5 –HDL. Then, we proceeded with the cortisol, which samples were processed. They were thawed just once. They were homogenized, removing this way the particulate matter by centrifugation or filtration. The reagents were added, and we gave it the proper time to minimize the difference in reaction time within the microwells. After each pipetting, they were gently shaken and then incubated for 60 minutes. The absorbance of the calipers and the samples is determined by using an ELISA microwells reader or by using fully-automatized systems. The analysis are validated when the mean absorbance of A-G A is higher or same as 1, and the difference between duplicates of Cal-A is not higher than 10%.

Ethical Aspect

The results were sent exclusively to each one of the participants, respecting their privacy, so this result can be used to benefit their health. The approval of each participant to be subject of study was confirmed by an information consent, where it is explained the purpose and benefit of said

study.

This study belongs to category 2 (minimal risk). Its realization was approved by the councils of investigation of each hospital.

Results

Down below, the summary of the results of the study is presented, in which 80 students participated.

Table 1.
Characteristics of the students (n = 80)

Variable	Category	Frequency	%
Sex	Female	42	52.5
	Male	38	47.5
Age	20-25 years old	61	76.5
	26-30 years old	19	23.8
Academic Year	External (4th and 5th year)	50	62.5
	Internal (6th year)	30	37.5
Hospital	Roosevelt	18	22.5
	General San Juan de Dios	18	22.5
	Pedro de Bethancourt	15	18.8
	Escuintla	15	18.8
	Cuilapa	14	17.5
Service	Obstetrics and gynecology	25	31.3
	Internal Medicine	22	27.5
	Surgery	20	25.0
	Pediatrics	13	16.3

In Table 1, it can be observed that the sex distribution was similar (f = 52.5 % vs. m = 47.5 %); and had a higher frequency in ages between 20 and 25 years old (76.3%), 4th and 5th year students (62.5%). Hospitals distribution was similar; however, there were more students in Guatemala City Hospitals (45.3%). The services with more evaluated students were Obstetrics and Gynecology and (31.3%) and Internal Medicine (27.5%).

Table 2.
Lifestyles before work shift (n = 80)

Lifestyle	Before Work Shift
	f (%)
Alcohol Consumption	17 (21.3)
Energy Drinks Consumption	9 (11.3)
Caffeine Intake	50 (62.5)
Tobacco Consumption	13 (16.3)
Sleep Hours (< 5 hours)	16 (20.0)
No Physical Activity	66 (82.5)
Inadequate Nutrition	56 (70.0)

In addition, it can be observe in Table 2 that one fifth of the students did consume alcohol before work shift (21.3%), 11.3% consumed energy drinks; and 16.3%, tobacco. Out of the students, 82.5% does not do any physical activity, and 70.0 % did not have an adequate nutrition.

Table 3.
Biochemical tests and vital signs before and after work shift (n = 80)

Variables	Before $\bar{x}$ (s)	After $\bar{x}$ (s)	Value p
Heart Rate (ppm)	78.80 (10.86)	78.56 (8.2)	.849
Body Temperature (°C)	36.72 (0.35)	36.68 (0.34)	.375
Cortisol (μg)	141.05 (71.05)	159.74 (69.37)	.023
Blood Sugar (mg/L)	103.15 (14.63)	97.51 (9.80)	.002
Cholesterol HDL (mg/dL)	56.46 (14.79)	54.76 (13.62)	.145
Cholesterol LDL (mg/dL)	71.50 (28.75)	72.96 (30.74)	.678
	Me (Q1, Q3)	Me (Q1, Q3)	
Systolic Blood Pressure (mmHg)	110.00 (110.00. 120.00)	110.00 (100.00. 120.00)	.402
Diastolic Blood Pressure (mmHg)	70.00 (70.00. 80.00)	70.00 (60.00. 80.00)	.457
Breathing Rate (rpm)	16.00 (16.00. 17.00)	16.00 (16.00. 17.00)	.124
Cholesterol mg/dL)	159.00 (140.00. 183.50)	157.50 (135.50. 173.00)	.368
Triglycerides (mg/dL)	144.00 (113.50. 192.50)	133.00 (109.00. 180.50)	.050

In Table 3, it can be observed that there was a significant decrease in the values of glycaemia after the work shift (p = .002), a significant increase of cortisol (p = .023), and a decrease in triglycerides levels (p = .050).

We assessed if the values of the response quantitative variables (glycaemia, triglycerides, cortisol, etc.) vary after work shifts depending on academic year, sex, or hospital, but we did not find any significate difference.

Discussion

This study was developed in Roosevelt, San Juan de Dios, Regional de Cuilapa, Regional de Escuintla and Nacional de Antigua Hospitals; with 80 students who were asked a series of questions related to their lifestyles. Their vital signs were taken, as well as a blood test to measure glycaemia, lipid profile, and cortisol before and during the work shift, from February to May, 2016.

We asked questions about their habits before and after work shift, so we

determined that before the work shift, it was more common that students did not do any physical activity (82.5%), did not have adequate nutrition (70.0%), and consumed caffeine (62.5%). In addition, 80% of the students stated that they slept 5 hours or more.

Several studies have been carried out to record the effect of sleep and eating habits. According to a study developed by the University of Granada, Spain, it is estimated that 75% of the population sleeps more than 7-8 hours every night (Barriga-Ibars, Rodríguez-Moratinos, Esteban, & Rial, 2005). Regarding the study carried out in resident medical interns (MIR, Spanish acronym for *Médicos Internos Residentes*), in 2007, who implemented the campaign *Llevo 32 horas sin dormer, ¿te opero?* (I have been awake for 32 hours. Do you need a surgery?), showed the deterioration of the patients attention quality due to physical wear of medical staff (Santos, 2007). In Santiago de Chile, it was confirmed that sleep deprivation combined with poor nutrition increases the risk of suffering metabolic and mood disorders at a 58%. Nevertheless, the found information was not significant due to the adaptive process to which the student is subjected, developing said disorders in the long term (Durán, Fuentes, Vásquez, Cediel, & Díaz, 2012).

Two thirds of the students of this study consumed more than one cup of coffee per week. One cup of coffee contains around 100 mg of caffeine, considering that 600 mg of caffeine a day can cause metabolic alterations according to a study carried out in 2011 in the Faculty of Medicine in Bogotá (Chin, Merves, Goldberger, Sampson-Cone, 2008; Core-Menéndez, Rangel-Garzón, Sánchez-Torres, & Medina-Lemus, 2001).

According to the World Health Organization categorizes regular alcohol consumption when it happens at least once a week or twice a year (Metal Health and Substance Abuse Unit, 2010). It was determined that 25% of the students had drunk alcohol before work shift, taking as a reference once a week as the minimum consumption; whereas after work shift, only 1.3% had drunk.

In this study, it was determined that 11.3% of students consume energy drinks before work shift, and 10% consume energy drinks during work shift. There was not statistical significance in these students. However, in a research carried out by Henry Ford Hospital in the United States of America, in 2011, where students consumed energy drinks for an entire week, students presented an increase in blood pressure and heart rate, 11% and 7%, respectively. Therefore, modifications on the metabolic profile will be influenced by the frequency consumption (Cote-Menéndez *et al*., 2011).

Another study in medicine students of Santa Marta, Colombia, showed a tobacco consumption of 6% (Ceballos, Del Gordo, & Campo-Arias, 2006). In this study, one fifth of the assessed students consumed tobacco before and after work shift, which tripled the results of the first study.

It was determined that students, depending on their lifestyles, do not do any physical activity more than three times a week. This is twice more than what was found in a study carried out in Villa Nueva, Guatemala, where

researchers discovered that sedentariness in university students is above 42.9%, making clear that stress and study load levels influence the lack of physical activity (*Programa Nacional de Enfermedades Crónicas*, 2008).

Although it is known that cortisol levels are related to high stress levels, in this study, stress in students was not assessed with psychometric instruments. In the study of Li, cortisol levels in day and night workers were compared. Here, it was observed that night-shift workers cortisol levels are higher due to alterations in day metabolic patterns of cortisol (Li *et al*., 2008).

In Mexico, a study with nursery, odontology, and medicine students who did not have stablished schedules was carried out. These students show lower blood sugar levels, and had poor performance at work, as well as anxiety and adynamia disorders (Aguiano, 2012). In this study, we had similar results, where two thirds of the assessed students show a decrease in blood sugar level after work shift.

Regarding the findings in lipid profile measurement, it was only observed a decrease in triglyceride levels. It is important to remember that the metabolism of fatty acids in different organism behaviors is produced quickly in response of various stimuli such as diet, stress, etc. In other studies it has been observed that long-term changes in triglyceride levels and not immediate changes. However, according to Kiranmala, Aslam, Mishra, Jhamb, and Madhu (2019), there is a direct relationship between resistance to insulin and triglyceride levels. And, since in this study, we observed a decrease in glucose after work shift, it can be conclude that assessed individuals do not show resistance to insulin, and that the difference between triglycerides before and after work shift is explained simply by prolonged fasting in relation to work shift.

When the metabolic variables and the vital sings was made, ho difference was found regarding sex, age or hospital.

It is concluded that the metabolic profile of medical students after work shift is found with low glycaemia and triglycerides levels, and high levels of cortisol. However, due to limited resources, it was not possible to complete a metabolic profile with thyroidal and renal function tests, to determine the alterations in a better way.

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