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Excess weight in regular aviation pilots associated with work and sleep characteristics[☆]



Magna Lúcia de Souza Palmeira, Elaine Cristina Marqueze*

Department of Epidemiology, Post-Graduate Program in Public Health, Catholic University of Santos, Av. Conselheiro Nébias, 300, Vila Mathias, Santos, SP 11015-001, Brazil

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ABSTRACT

Objective: To identify the prevalence and associated factors of overweight and obesity in Brazilian commercial airline pilots.

Methods

An observational, cross-sectional study involving 1198 Brazilian commercial airline pilots with a sampling power > 80% ($\beta=20\%$) and confidence level of 95% ($\alpha=5\%$) was carried out. The pilots completed an on-line questionnaire collecting data on sociodemographics, work, health, lifestyle and sleep. Poisson regression, with robust variance (stepwise forward technique), was employed to analyze the factors associated with excess weight (overweight and obesity). The models were adjusted for the variables age, marital status and education. The data were analyzed using the STATA 12.0 program.

Results: The prevalence of overweight among the pilots was 53.7% and of obesity was 14.6%. The probability of being overweight was highest among pilots working night shifts for 6–10 years and that had difficulty relaxing after work, where perceived morningness was a protective factor. Risk factors for obesity included working night-shifts for 6–10 years, having difficulty relaxing after work, sleeping < 6 h on days off, having other diagnosed diseases, and practicing < 150 min/week of physical exercise.

Conclusion: It was concluded that the prevalence of overweight and obesity among the commercial airline pilots was high and represents a public health problem in this population. Excess weight was associated with time working night-shifts, difficulty relaxing after work, inadequate sleep on days off, having other chronic diseases, and physical inactivity. In this context, nutritional status can be regarded as the result of dynamic and complex interactions promoted by occupational, sleep and health factors.

1. Introduction

Obesity is a public health problem, given the elevated risk of morbidity and mortality [1]. It constitutes a global problem that has reached epidemic proportions worldwide [2]. Besides the numerous consequences for physical and mental health, obesity represents a financial burden for public expenditure [3]. Among the known causes leading to overweight, such as changes in lifestyle (irregular meal times and physical inactivity) and food standard (food easy to prepare and highly caloric, i.e. fast-food), organizational factors also have it has been recognized as an important cause of obesity among workers [4,5]. Generally, pilots are subject to a host of adverse working conditions such as irregular and long work shifts and transmeridian flights. These adversities faced by pilots have a significant impact on rest and sleep, factors that can have deleterious effects on their health, including metabolic problems

such as excess weight [2,6,7].

Circadian disruption, a consequence of shift work, has significant effects on regulation of body weight and on the ratio of leptin/ghrelin, hormones controlling appetite, and is thus a factor causing an imbalance in eating behavior. In summary, the disturbances caused by changes in sleep and rest times influence appetite, satiety and consequently food intake, promoting weight gain irrespective of physical activity [2,5,8,9,10].

A number of studies to determine which occupational characteristics are risk factors for excess weight and the deleterious effects of work organization on workers' health have been proposed [3,4]. Given the current dearth of data on excess weight in Brazilian commercial airline pilots, as well as on associated risk factors, the objective of the present study was to identify the prevalence and associated factors of overweight and obesity.

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[☆] Corresponding author.

E-mail addresses: magna-palmeira@bol.com.br (M.L. de Souza Palmeira), elaine.marqueze@unisantos.br (E. Cristina Marqueze).

2. Methods

An observational, cross-sectional investigation based on data derived from the study called “Assessment of chronic fatigue in Brazilian pilots” [11], was carried out. The study population comprised 2350 airline pilots, members of the Brazilian Association of Civil Aviation Pilots (ABRAPAC). Of this total, 1234 agreed to take part in the present investigation, representing 52.5% of the original study cohort. Executive, cargo and air-taxi aviation pilots were excluded, as were female pilots, owing to their small number and the biological difference in the study outcome, giving a final study sample of 1198 pilots. Initially the sample size was calculated to meet the objectives of the research “Chronic fatigue, working conditions and health of Brazilian pilots” (MARQUEZE et al., 2014¹). For the present study, the statistical power of the sample was calculated a posteriori. The sample power of the present study was superior to 80% ($\beta = 20\%$) and 95% confidence level ($\alpha = 5\%$), having as parameter the prevalence of obesity of the sample analyzed (14.6%). Sample power was calculated using the G*Power 3.1.4 program.

Data collection was performed by means of an on-line questionnaire applied between October 2013 and March 2014. The dependent variables were overweight and obesity, where these were obtained by calculating Body Mass Index (BMI) based on self-reported body mass and height of the pilots, measures which, according to Dekkers et al. [12], are valid for cross-sectional, epidemiological studies. BMI was calculated as proposed by the World Health Organization [13]. The scores obtained were categorized into: Normal (18.50–24.99 kg m [2]), Overweight (25.00–29.99 kg m [2]) and Obesity (≥ 30.00 kgm²) [14]. According Santos and Sichieri [15], BMI represents a good indicator of nutritional status.

The independent variables were sociodemographic characteristics (age, marital status and education); work characteristics (flight route, work shift: day or irregular, time working as pilot, time working night-shifts, average monthly flying hours, maximum number of consecutive work days, maximum number of consecutive work nights, start time of morning shift, perceived level of fatigue); health and lifestyle characteristics (smoking – this variable was assessed by a single question – consumption of alcoholic beverages or otherwise with yes/no options, physical activity – assessed by a single question on weekly physical activity time, categorized as ≥ 150 min/week or < 150 min/week). Level of physical activity was categorized based on the recommendations established by the Centers for Disease Control and Prevention (CDCP) and the American College of Sports Medicine (ACSM) [16], and subsequently by the World Health Organization (WHO) [17]; diagnosed diseases - this question was taken from the Work Ability Index (WAI) [18] and dichotomized into yes or no, being classified as yes for those reporting a clinically-diagnosed disease; sleep characteristics – quality of sleep indexes (good or poor), problems awaking (yes or no) and of drowsiness/sleepiness (yes or no). These indexes were obtained using the Karolinska Sleep Questionnaire – KSQ [19]. Perceived adequate sleep was also assessed by a single question adapted from the KSQ [19] and dichotomized as yes or no, sleep duration after night and day shifts in hours, categorized into > 8 h, 6–8 h and < 6 h, sleep duration during days off in hours, categorized into > 8 h, 6–8 h and < 6 h, perceived sleepiness/drowsiness – assessed by a single question and categorized into never or rarely, sometimes, often or always, difficulty relaxing after work – assessed by a single question dichotomized as yes or no, need for recovery after work – using the scale of Veldhoven and Broersen [20] with scores ranging from 0 to 100 points proportional to the need for recovery. The score obtained was categorized based on the tercile and classified into less, moderate or

greater need for recovery after work, perceived chronotype – assessed by a single question adapted from the KSQ [19], categorized into intermediate, morningness or extreme morningness, eveningness or extreme eveningness.

The Chi-squared and Fisher's exact hypotheses tests were used for comparing proportions. Poisson regression with robust variance was employed to analyze the factors associated with excess weight (overweight and obesity), allowing identification of both risk and protective factors in qualitative variables having a high prevalence ($> 10\%$) with lower bias in prevalence ratios [21].

Based on the results of the hypotheses tests, independent variables with $p < 0.20$ were tested on the multiple Poisson regression model in increasing order of statistical significance (stepwise forward technique). The models were adjusted for the variables age, marital status and education. For all tests, a “p” value of < 0.05 was considered significant. Data were analyzed using the STATA 12.0 program (Stata corp, Texas, USA).

The ethical issues related to research in human beings were duly respected, and the project was approved by the Research Ethics Committee of the Federal Institute of Education, Science and Technology of São Paulo (protocol number 625158).

3. Results

The pilots that participated in the study were all male and had a mean age of 39.2 years (SD=9.8 years), range 21–67 years. Mean time working in the profession was 15.3 years (SD=10.1) and in the present company was 5.9 years (SD=4.8 years). The mean monthly flying hours reported was 65.4 h (SD=9.6 h) and mean time off was 9.2 days (SD=1.4 days). The mean work day duration was 8.8 h (SD=1.4 h) for the morning shift, 8.0 h (SD=1.7 h) for the evening shift and 7.6 h (SD=6.5 h) for the night shift.

Regarding Body Mass Index (BMI) of the pilots, the prevalence of overweight was 53.7% and of obesity was 14.6%.

A large proportion of pilots who had a partner (88.5%) ($p < 0.01$), were aged ≥ 39 years (52.2%) ($p < 0.01$), had worked in the profession for ≥ 11 years (63.9%) ($p < 0.01$), worked night-shifts in the profession for ≥ 6 years (29.6%) ($p = 0.02$), had diagnosed diseases (48.5%) ($p < 0.01$) and difficulty relaxing after work (50.3%) ($p = 0.04$) were overweight.

On the bivariate model, having diagnosed diseases, sleeping < 6 h on days off, working as a pilot for > 10 years, working the night-shift for ≥ 16 years, having sleepiness often or always and difficulty relaxing, were associated with overweight (Table 1).

On the adjusted multiple model, working night shifts for 6–10 years and having difficulty relaxing continued to be associated with overweight, where perceived morningness was a protective factor based on the inter-relationship of the above-cited independent variables (Table 1).

The majority of obese pilots were aged ≥ 39 years ($p < 0.01$), had a partner (a) ($p < 0.01$), secondary education or below ($p = 0.04$), worked in the profession for ≥ 21 years ($p < 0.01$) and on night-shifts for ≥ 6 years ($p = 0.01$), practiced ≤ 150 min of weekly physical activity ($p < 0.01$), had diagnosed diseases ($p < 0.01$), ≤ 6 h of sleep during days off ($p = 0.01$) and difficulty relaxing after work ($p < 0.01$). There was also a tendency for a greater proportion of pilots with sleepiness to be obese than eutrophic ($p = 0.06$).

On bivariate analysis, sleepiness, < 150 min of weekly physical exercise, diagnosed diseases, sleeping < 6 h on days off, working ≥ 21 years as a pilot, working for 6–10 years and ≥ 16 years on night-shifts, and difficulty relaxing after work, were associated with obesity (Table 2).

On the adjusted multiple model, < 150 min of weekly physical activity, diagnosed diseases, inadequate sleep during days off, working 6–10 years on night-shifts, and difficulty relaxing after work were associated with obesity (Table 2).

¹ Marqueze EC, Diniz DHMD, Nicola AC. Fadiga crônica, condições de trabalho e saúde em pilotos brasileiros. Associação Brasileira de Pilotos da Aviação Civil - ABRAPAC, 2014. Disponível em: <http://www.pilotos.org.br/safety/2287-pesquisa-de-fadiga-veja-o-relatorio-final>.

Table 1
Crude and adjusted prevalence ratios (PR) of factors associated with overweight among Brazilian commercial airline pilots. Brazil.

Variables	Bivariate PR (95% CI)	Multiple ^a PR (95% CI)
Flight route		
National	1	
International	1.13 (0.98–1.30)	n.s.
Perceived adequate sleep		
Yes	1	
No	0.94 (0.84–1.04)	n.s.
Maximum number of consecutive work days		
≤6 days	1	
≥7 days	1.10 (0.98–1.23)	n.s.
Weekly physical activity		
≥ 150 min/week	1	
< 150 min/week	1.08 (0.98–1.19)	n.s.
Diagnosed diseases		
No	1	
Yes	1.15 (1.05–1.27)	n.s.
Sleep duration during days off		
> 8 h	1	
6–8 h	0.97 (0.87–1.07)	n.s.
< 6 h	1.35 (1.09–1.69)	n.s.
Time working as pilot		
≤10 years	1	
11–20 years	1.18 (1.05–1.33)	n.s.
21–30 years	1.28 (1.12–1.45)	n.s.
≥31 years	1.42 (1.23–1.64)	n.s.
Time working night-shifts		
< 1 year	1	1
1–5 years	0.97 (0.85–1.12)	n.s.
6–10 years	1.14 (0.99–1.30)	1.16 (1.02–1.32)
11–15 years	1.17 (0.97–1.41)	n.s.
≥16 years	1.26 (1.10–1.45)	n.s.
Perceived sleepiness		
Never	1	
Sometimes	1.00 (0.90–1.12)	n.s.
Often or never	1.15 (1.02–1.29)	n.s.
Difficulty relaxing after work		
No	1	1
Yes	1.11 (1.01–1.22)	1.14 (1.04–1.25)
Perceived chronotype		
Intermediate	1	1
Morningness or extreme morningness	0.91 (0.79–1.04)	0.86 (0.75–0.99)
Eveningness or extreme eveningness	0.88 (0.77–1.01)	n.s.

Pearson goodness-of-fit=1.00; ROC area 64%.

^a Model adjusted for age, marital status and education.

4. Discussion

Considering the cross-sectional design of the present study, the data found here provide no evidence of causality, only association. However, this research is relevant to describe the characteristics of this population, until then little studied, as well as with such sample representativity. The study had good internal validity given the high sample power (over 80%), rendering it relevant to this professional category as the first study of its kind in the related literature, having included pilots from different airline carriers.

Based on the sample studied, a high prevalence of excess weight (overweight and obesity) was found in Brazilian commercial airline pilots. This prevalence was similar to the rate found in a population of

Table 2
Crude and adjusted prevalence ratios (PR) of factors associated with obesity among Brazilian commercial airline pilots. Brazil.

Variables	Bivariate PR (95% CI)	Multiple ^a PR (95% CI)
Flight route		
National	1	
International	1.27 (0.87–1.87)	n.s.
Sleepiness index		
No	1	
Yes	1.61(1.04–2.49)	n.s.
Weekly physical activity		
≥150 min/week	1	1
< 150 min/week	1.71 (1.32–2.21)	1.62 (1.27–2.06)
Diagnosed diseases		
No	1	1
Yes	1.66 (1.29–2.13)	1.37 (1.07–1.74)
Sleep duration during days off		
> 8 h	1	1
6–8 h	0.98 (0.74–1.28)	n.s.
< 6 h	2.52 (1.72–3.69)	1.77 (1.08–2.89)
Time working as pilot		
≥10 years	1	
11–20 years	1.35 (0.99–1.85)	n.s.
21–30 years	1.69 (1.21–2.36)	n.s.
≥31 years	2.37 (1.66–3.38)	n.s.
Working time night-shifts		
< 1 year	1	1
1–5 years	0.94 (0.66–1.36)	n.s.
6–10 years	1.45 (1.04–2.03)	1.51 (1.10–2.07)
11–15 years	1.53 (0.96–2.44)	n.s.
≥16 years	1.74 (1.20–2.52)	n.s.
Maximum number of consecutive work nights		
1–2 nights	1	
3–4 nights	0.78 (0.55–1.09)	n.s.
≥5 nights	0.94 (0.65–1.35)	n.s.
Difficulty relaxing after work		
No	1	1
Yes	1.45 (1.13–1.85)	1.36 (1.06–1.74)
Need for recovery after work		
Less need	1	
Moderate need	0.91 (0.66–1.25)	n.s.
Greater need	1.19 (0.89–1.59)	n.s.

Pearson goodness-of-fit =1.00; ROC area 75%.

^a Model adjusted for age, marital status and education.

Brazilian men aged 18 years or older with a prevalence of overweight of 56.5% and obesity of 17.6%, which is considered very high [22].

A study by Marqueze et al. [5] comparing the prevalence of overweight and obesity of Brazilian truck drivers who worked irregular shifts and had a high prevalence of overweight (51.6%) and obesity (22.6%) revealed that the pilots had slightly higher rates of overweight and slightly lower rates of obesity than truckers. The study of Whitfield-Jacobson et al. [23], also involving truck drivers, in Sao Paulo, southeastern of Brazil, found 85.9% prevalence of excess weight and, of this group, 56.5% were classified as obese. The descriptive, cross-sectional by Freitas et al. [24] assessing nutritional status of civil construction workers also identified a high prevalence of overweight (41.9%) although this was lower than the rate found among the pilots. The same study, however, reported a higher prevalence of obesity (22.6%) than that of the pilots.

The above-cited studies, akin to the present investigation, found

high prevalences of excess weight. Some similar aspects among these professional categories can be noted, such as working irregular hours, unavailability of healthy food, irregular hours for meals, short rest times owing to the long working day and poor sleep quality.

By contrast, the study conducted by Fernandes and Vaz [25] involving 366 Brazilian young workers of construction company (aged 21–25 years), found a lower prevalence of both overweight and obesity (33.1% and 6.5%, respectively) compared to the pilots studied. The same was observed in the study of Souza et al. [26], involving 15 Brazilian rubber-tappers and 30 cane cutters (mean age 29.86 years \pm 8.57 years), which also found a lower prevalence of excess weight, with 40% overweight and 6.7% obese among cane cutters; and 13.3% overweight and no obesity among the rubber-tappers. These lower prevalences of excess weight in the cited studies compared to pilots may be due to greater energy expenditure associated with the type of work performed, i.e. largely physical. Another relevant factor is the lower age of the participants and that both studies involved small samples of workers.

The high prevalences of overweight and obesity found in the present study represent a worrying situation given the pilots were young adults and that excess weight is associated with many chronic diseases such as type II diabetes, arterial hypertension, stroke, cardiopathies, dyslipidemias and many other debilitating diseases [27,28].

4.1. Working time night-shifts

Of the risk factors associated with excess weight among the pilots, time working night-shifts was a risk factor for both overweight and obesity. According to Kooler [29], workers whose activities were organized in shifts exhibited a marked decline in performance during the first few years of work. Over the course of many years, this phenomenon tended to worsen owing to burnout, causing irreparable harm and leading to deleterious effects on workers' health. Moreover, Kooler [29] reported that, in the first five years of working night-shifts, changes in living habits occurred (sleep, diet, social activities), a phase referred to as adaptation. Workers that cannot overcome the difficulties associated with the inverted sleep-wake cycle in this phase ultimately give up the job. If night-shift work continues, the sensitization phase occurs in which the risks cumulate and chronic deleterious effects begin to emerge.

In a study of taxi drivers, in Japan, Ueda et al. [30] reported that those who had spent more years in the profession had a greater propensity for being obese. Besides excess weight, time working night-shifts is strongly associated with metabolic disorders [3,31].

Canabarro and Rombaldi [32], assessing the risk of obesity and visceral obesity among firefighters from the Fire Service of Pelota, Rio Grande do Sul state, in relation to time in the service, concluded that firefighters who had worked longer had greater indicators of obesity, being more exposed to the risks associated with excess body fat.

Other results similar to those of the present study were also found in the studies of Amelvoort et al. [33], in Netherlands, who reported a possible relationship between time working shifts and BMI, and in the investigation conducted by Niedhammer et al. [34], in France, showing an association between the prevalence of weight gain and time working night-shifts.

4.2. Difficulty relaxing after work

Weight gain is also regarded as an important risk factor for development of sleep disorders that hamper relaxation [35].

Some individuals that have difficulty relaxing after work make use of relaxation-inducing substances such as alcoholic beverages. This behavior can be learned by observation [36] via the model of others^a and may prove ineffective, in as far as alcohol can cause sleep fragmentation [37], while also producing negative effects in personal, social and professional settings [38].

4.3. Physical activity

Another notable aspect is the relationship between physical activity and excess weight. In the present study, there was a greater proportion of individuals with excess weight among those doing less than 150 min of weekly exercise, i.e. insufficient duration to promote health [39]. A study conducted by Santos and Coelho [40] investigating physical activity levels and obesity prevalence in a representative sample of workers from Joinville, Santa Catarina state, found a significant association between physical activity during leisure-time and obesity ($p < 0.05$), a finding corroborated by the results of the present study.

Numerous studies have shown the benefits of regular physical activity, one of which is control of body weight [41,42]. In contrast, physical inactivity can lead to a series of chronic conditions in the organism, such as heart disease, cancer, diabetes, osteomuscular and psychiatric disorders, as well as hypertension and obesity [43].

According to the study by Ishitani et al. [44], today's Brazilian people has much lower caloric expenditure than years ago, explaining the emergence of a number of diseases related to physical inactivity. The decrease in levels of physical activity and its association with the rise in obesity is due to changes in the processes of work and leisure, a reduction in sports, and lower energy expenditure in daily activities [45].

Generally, shift workers face many obstacles for physical activity, including irregular work hours and discomfort practicing such activity. According to Atkinson [46], shift workers report discomfort when doing physical exercise, along with fatigue, where these symptoms stem from circadian disruption, making it difficult to pursue an active life style.

In addition to physical inactivity, time spent sitting during the day also had a negative impact on health. In many jobs, workers remain seated for practically the whole work day, as is the case of airline pilots. A study by Marqueze et al. [5] found that Brazilian truck drivers working irregular shifts spent longer sitting during the week than day-shift workers (745.2 versus 641.5 min, respectively, $p=0.05$). A study conducted by Northwestern Medicine in the USA found that even when individuals do physical exercise, sitting for the rest of the day is harmful and a factor responsible for the rise in obesity cases [47].

Geliebter et al. [48] recommended the incorporation of physical activity into the routine of night workers, because its benefits act on the organism, protecting the body from the effects of short sleep, promoting a more heightened state of wakefulness compared to individuals not doing physical exercise, and also greater readiness for work [49].

4.4. Diagnosed diseases

The results of the present study also showed that diagnosed chronic diseases were associated with excess weight. A direct relationship exists between obesity and other chronic diseases, causing reduced quality of life, shorter life expectancy and increased mortality [50,51].

In the study of Gigante [52] in Brazil, on the prevalence of obesity in adults, hypertensive and diabetic individuals had a 2.6 times higher risk of being obese compared with health individuals. Ogata [53] holds that Brazilian companies should invest in body weight reduction programs, given that both overweight and obesity are strongly associated with increased care costs, as well as with absenteeism. Weight loss leads to improvement of associated chronic diseases and lowers risk factors and mortality. Excess weight can be attenuated or prevented through changes in lifestyle [54], such as switching from night to day shifts [55], doing at least 150 min of weekly physical activity (WHO, 2011), and trying to relax after work and achieve better quality sleep [56].

4.5. Short sleep duration

Inadequate sleep during days off also represented a risk factor for

excess weight among the pilots. Sleep curtailment can seriously affect health, since various metabolic processes, when altered, can affect the balance of the organism in the short, medium and long terms [9].

A number of studies have been proposed to elucidate the association between inadequate sleep and obesity, in which less than 6 h of sleep is associated with high BMI [56]. Gangwisch et al. [57] analyzed the cross-sectional and longitudinal data of a large sample from the United States to determine whether sleep duration was associated with obesity and weight gain. The results supported the hypothesis that short sleep duration is associated with obesity, for which interventions improving the amount and quality of sleep are needed.

In a Spanish study carried out by Vioque et al. [58], the authors found that sleep time ≤ 6 h per day increased the risk of obesity, where the group which slept ≤ 6 h had a higher BMI than the group that slept 9 h ($27.7 \text{ kg/m}^2 \times 24.9 \text{ kg/m}^2$, respectively). In an experiment performed in the US, by Spiegel et al. [56], sleep curtailment in men was associated with a 28% elevation in ghrelin levels, 18% decrease in leptin levels, 24% increase in hunger and 23% in appetite. These results suggest that modified sleep patterns can lead to endocrine imbalances that induce the development of obesity.

4.6. Chronotype

Another relevant aspect that warrants attention concerns chronotype. Some studies have revealed that individuals with eveningness chronotype generally have a higher body mass index (BMI) and poorer dietary habits (eating later, in greater amounts at the end of the day and consuming more fast food and soft drinks) [59–61].

Kanerva et al. [62], in a cross-sectional study including 4493 patients from the 2007 National FINRISK study aged 25–74 years, explored whether human chronotype was associated with food and nutrient intake. The results supported evidence that individuals with eveningness chronotype have less healthy lifestyles, such as unhealthier eating habits, than those with a tendency toward morningness, placing them at greater risk of chronic diseases. In the present study, morningness chronotype was a protective factor for overweight. This finding can be partly explained by the fact that the morningness chronotype is associated with a healthier and more regular lifestyle than the eveningness type [63,64].

In a recent review by Reutrakul and Knutson [64] in Thailand, assessing chronotype in circadian disruption and cardiometabolic health of shift workers, the authors reported several studies that found an association between eveningness and metabolic disorders. The main findings were the presence of higher BMI, lower HDL levels, higher triglyceride levels and glycemic problems among eveningness types compared to morningness types.

Limitations of the present study included its convenience sample, in which only pilots who were members of ABRAPAC were asked to take part in the study. The study data should be interpreted with caution because the findings cannot be generalized for all Brazilian commercial airline pilots.

5. Conclusion

It was concluded that the prevalence of overweight and obesity among the Brazilian commercial airline pilots was high and represents a public health problem in this population. Excess weight was associated with time working night-shifts, difficulty relaxing after work, inadequate sleep on days off, having other chronic diseases, and physical inactivity. In this context, nutritional status can be regarded as a result of dynamic and complex interactions promoted by occupational, sleep and health factors.

The results of the present study serve in the introduction of new protective measures for the health of airline pilots, recognizing excess weight as a risk factor for physical, mental and social health, which is often determined by work conditions and organization.

The magnitude of this problem points to an urgent need for planning educational actions promoting health, public policies, and projects run by the state and airline companies that seek to improve the health and quality of life of pilots.

Lastly, there is a need to broaden the debate among different areas involved in the obesity and health of workers, furthering studies and addressing the issue in an interdisciplinary manner, thereby acknowledging the extent of this problem.

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