Sport Sciences for Health (2023) 19:309–319
https://doi.org/10.1007/s11332-022-00963-8

ORIGINAL ARTICLE

Evening chronotype predicts dropout of physical exercise: a prospective analysis

Flávio Augustino Back[1,4] · Adriano Akira Ferreira Hino[2] · Wilynson Gomes Bojarski[1] · João Manoel Gonçalves Aurélio[1] · Cláudia Roberta de Castro Moreno[3] · Fernando Mazzilli Louzada[1]

Received: 29 December 2021 / Accepted: 11 May 2022 / Published online: 20 June 2022

Abstract

Purpose Eveningness preference to sleep/wake and perform physical/cognitive activities has been associated with worse health outcomes, when compared to morningness preference. Physical activity is one potential mediator that could explain this relationship; however, most of these evidences come from cross-sectional design studies. Our goal was to assess whether chronotype could predict the risk of dropout of physical exercise programs.

Methods We followed 153 newly enrolled volunteers at three different gyms, from both sexes, aged between 18 and 65 years, during 12 weeks. The daily frequency of exercises in the programs was objectively measured (gym's electronic turnstiles). Using questionnaires, we collected data of variables related to demographic characteristics, health, physical activity, sleep, anthropometric and chronobiological parameters (Morningness–Eveningness Questionnaire—MEQ). Two multivariate models were created using Cox regression analysis to test the risk of dropout of physical exercise practice. Both models accounted for age, educational level, civil status, membership plan duration, physical exercise practice frequency during week 1 and chronotype (MEQ score and chronotypes).

Results Model 1 results showed that higher MEQ score was associated with a lower chance of quitting the program (HR = 0.98; CI95% 0.95–1.00; $p = 0.046$). Considering the chronotypes, E-types showed the highest dropout risk compared to that of M-types (HR = 2.22; CI95% 1.09–4.52; $p = 0.027$).

Conclusion Our results suggest that chronotype is another variable to be considered in future studies on promoting PAs in formal environments. Likewise, the practice frequency during week 1 and duration of membership plan also deserve more attention in additional studies.

Keywords Chronotype · Circadian preference · Exercise · Longitudinal · Gym

Introduction

The development of technology and urban centers are associated with harmful health trends such as spending more time in the sitting position and less body motion [1]. Such phenomena have become so common that we are experiencing a global physical inactivity epidemic [2], portrayed as the fourth major leading cause of death [3]. Katzmarzyk et al. [4] relied on the largest and most recent meta-analyses and estimated that, globally, up to 8% of all-cause deaths are attributable to physical inactivity.

In urban centers, people's daily body posture has been characterized as sedentary behavior (energy expenditure between 1 and 1.5 METS, multiples of the basal metabolic rate) at work, leisure and during commuting [5, 6]. Spending long periods sitting creates a deficit in physical activity (PA)

✉ Flávio Augustino Back
flaviotaiguara@yahoo.com.br

1 Human Chronobiology Laboratory, Department of Physiology, Federal University of Paraná, Curitiba, Paraná, Brazil

2 Health Sciences Graduate Program, School of Medicine, Pontifícal Catholic University of Paraná, Curitiba, Paraná, Brazil

3 School of Public Health, University of São Paulo, São Paulo, Brazil

4 Physiology, Universidade Federal do Parana Setor de Ciencias Biologicas, Av. Cel. Francisco H. dos Santos, s/n, Curitiba 81531-980, Brazil

(defined as any movement created by the skeletal muscles that results in energy expenditure)[7]. In this context, the practice of physical exercise (PA performed to develop or maintain physical fitness) during leisure time is highlighted as an important domain of PA to surpass this energy expenditure deficit [8]. It is noteworthy to emphasize that regular practice of exercises can also elicit significant phase-shifting effects on the circadian timing system [9]. This exercise synchronizing function varies with chronotypes [10] and can be explored in different directions, phase advance and delay, depending on social temporal needs.

In addition to PA, sleeping and waking hour distribution has been modified in urban societies as well, becoming more widespread and shifting toward eveningness—an effect proportional to the city size [11, 12]. Evidences show that delayed sleep onset time is negatively associated with total PA levels [13]. Chronotype evaluation, proposed by Horne and Ostberg [14], allows an exploration of this phenomenon through the Morningness–Eveningness Questionnaire (MEQ).

Three categories of chronotypes are put forward from the answers to this questionnaire: Morning types (M-types), Neither types (N-types) and Evening types (E-types). M-types prefer to sleep and wake up earlier, as well as perform PA and cognitive activities earlier [15]. Conversely, E-types prefer to perform physical and cognitive activities later, as well as later sleep and wake up. N-types show no trends toward more extreme bedtime and waking hours. These chronotypes express differences in body clocks, demonstrating an association with different biological markers, such as cortisol and melatonin rhythms, affecting physical and mental performance, and psychological and biological functioning in health and disease [16–21].

Cross-sectional studies with different populations have shown that E-types have lower levels of total PA when compared to M-types [22–30]. The E-type trait/state also predicts lower frequency of intentional physical exercise (any kind of physical exercise in which the volunteers wished to engage) during the month [31]. Two population-based cross-sectional studies show that E-type people obtained the lowest total levels of PA, adjusted for possible confounding variables and assessed both subjectively [32] and objectively [13].

Therefore, a combination of personal (biological and psychological), interpersonal (psychosocial) and environmental factors (physical and social) is linked to a physically active lifestyle and to different stages of physical exercise practice [33–36]. In this context, our objective in this study was to test whether chronotype might predict the dropout risk for physical exercise programs at gyms throughout 12 weeks. We hypothesize that E-types would present higher risk of dropout compared to M-types.

Methods

Study design

This study adopted an observational longitudinal design for 12 weeks. This time frame was defined as a period of physical activity practice, considering how important this step is in developing habit formation for physical exercise in gyms [37]. A convenience sampling was adopted at three different gyms in Curitiba, Paraná, Brazil (25º 25′ S, 49º 16′ W).

The three gyms had different monthly fees of U$18.00, U$25.00 and U$31.00, allowing access to all activities offered, including resistance and cardiorespiratory training as well as a variety of exercise options (for example: yoga, stationary bicycles, pilates, dance and martial arts classes …). The gyms had roughly 500, 480 and 1400 members and offered 15, 10 and 12 modalities of exercise options. The gyms' daily operation varied between 16.5 and 17 h on working days (6:00–23:00) and 5 and 8 h on weekends (8:00–16:00). All gyms had a team of physical education professionals to teach and supervise the activities, monthly, quarterly, semi-annual and annual membership plans and no trade or other reason to join the gym other than to exercise. Data collection occurred between February and December 2019.

Sampling

The sample consisted of fresh gym members enrolled for no longer than 2 weeks. With help from the staff and using an access software connected to electronic ticketing gates, the new members were identified. Then, our research team invited them to participate in the study. In a few cases, phone contact was obtained after proper authorization by the member. Inclusion criteria were: attending the gym for less than 2 weeks and age between 18 and 65 years. Exclusion criteria were: being pregnant or lactating, being a night worker or shift worker and being under personalized care (personal trainer).

Data collection procedure

Recruited volunteers were evaluated within 2 weeks after enrollment at the gym. Two baseline questionnaires were built using Google forms, and access links were sent through WhatsApp mobile message. The first questionnaire asked about identification, demographic characteristics, health and chronotype. From the second questionnaire, sleep, physical activity and psychosocial data were obtained. As soon as the first questionnaire was filled out (typically in 7–15 min) the second one was sent, taking 12–20 min to be handed off. On mean, it took 2.6 ± 3.4

and 3 ± 3.5 days for the volunteers to answer the first and second questionnaires, respectively. A physical evaluation was undertaken at either the first contact with the volunteers or scheduled within the following 2 weeks, by our previously trained research team. This evaluation covered body mass, height and abdominal circumference and was performed using a portable digital scale (Wizo®), an inelastic measuring tape on a vertical surface to 100 cm point distance of the ground and an inelastic, millimeter, anthropometric tape measure, respectively.

The volunteer's practice frequency in the programs was monitored along the following 12 weeks after their first registered entry. The use of an electronic presence control system was an inclusion criterion for the gyms. All three gyms included in this study had the same management software which was linked to electronic turnstiles. A special login was created for our research team so that they could get real-time data from the electronic turnstiles.

Finally, the volunteer's PA program was not created by the research team, nor did they supervise the type, duration and intensity of their training. The workouts included individual and group aerobic exercises and weight training.

Ethical concerns

The present study met the ethical values established by the National Council of Health and was approved by the ethical research committee of the Federal University of Paraná. The volunteers were given detailed instructions about the research procedures during their first physical evaluation. All volunteers agreed to sign a consent form and a digital copy was sent through WhatsApp messaging.

Tools and data processing

Chronotype evaluation

Chronotype was evaluated through the Morningness–Eveningness Questionnaire (MEQ) [11], validated for Portuguese language used in Brazil [38]. The score sum in MEQ ranges from 16 to 86, with higher scores indicating morningness and lower ones indicating eveningness. For analysis purposes, MEQ score was considered either a continuous or a categorical variable (E-type for scores lower than 42, N-type for scores between 42 and 58 and M-type for scores above 58).

Measuring sleep habit and sleep quality

Sleep timing was evaluated during workdays and free days through the Munich Chronotype Questionnaire (MCTQ) [39], validated for Portuguese language [40]. Sleep duration during work and free days was derived from these data, as well as social jetlag. Social jetlag was divided into three parts: below 1 h, between 1 and 2 h and above 2 h. Sleep quality was assessed through the Pittsburg Sleep Quality Index (PSQI) [41] in its Portuguese version validated for the Brazilian population [42]. PSQI assesses the sleep quality in the last 30 days with 19 questions categorized into seven components with scores ranging from 0 to 3. The sum of the components generates a score that ranged between 0 and 21; higher scores indicate worse sleep quality. Likewise, considering clinical criteria, scores above 5 indicate poor sleep quality.

PA evaluation

The short version of the International Physical Activity Questionnaire (IPAQ) validated for the Brazilian population [43] was used to assess the total level of PA [44]. From these data, the total energy expenditure was calculated in terms of metabolic equivalents per week (METS). A binary variable was created based on the recommended PA, either below 600 mets-minutes per week or equal to or greater than that. This measure was used to control the PA conducted beyond physical exercise at gyms programs.

Physical exercise frequency supervisioning at the gyms

Record at the turnstiles was used as an indication that physical exercise practice would be carried on since the gyms did not offer any service other than the practice of physical exercises. These attendance data were used in the calculation of the weekly mean frequency of practice during the first week and to follow the volunteer's presence. Those whose practice was interrupted for a period of subsequent 4 weeks or more, and canceled their membership plan, were classified as dropouts. This period was used in previous research [45, 46]. A period of 4 weeks without physical exercise sessions is considered a strong predictor of not exercising in the following 12 weeks [47]. Volunteers who kept practising with interruptions shorter than 4 weeks were classified as adherents.

Data analysis

All the characteristics were described according to the used measure scales. Qualitative variables were described in terms of frequency distribution and quantitative variables in terms of mean and standard deviation. Kaplan–Meier method was used to calculate the probability of dropout of physical exercise programs, according to the three chronotype groups and for the total of gym members. The results were presented as a survival curve (Fig. 1).

The association between chronotype and the dropout risk of physical exercise programs during a 12-week period was tested using a Cox proportional hazards model. A set of variables that were likely to be associated with the outcome of dropping out at 12 weeks was collected, for theoretical and empirical reasons, in a gym context. A multivariate model was created including the confounding variables which were associated with dropout risk at the level of $p < 0.05$ in the bivariate association (crude model). The chronotype was tested considering the MEQ score in which higher scores indicate morningness trend and a categorical variable classified into three chronotypes (E-types, N-types, and M-types). Therefore, two multivariate models were generated.

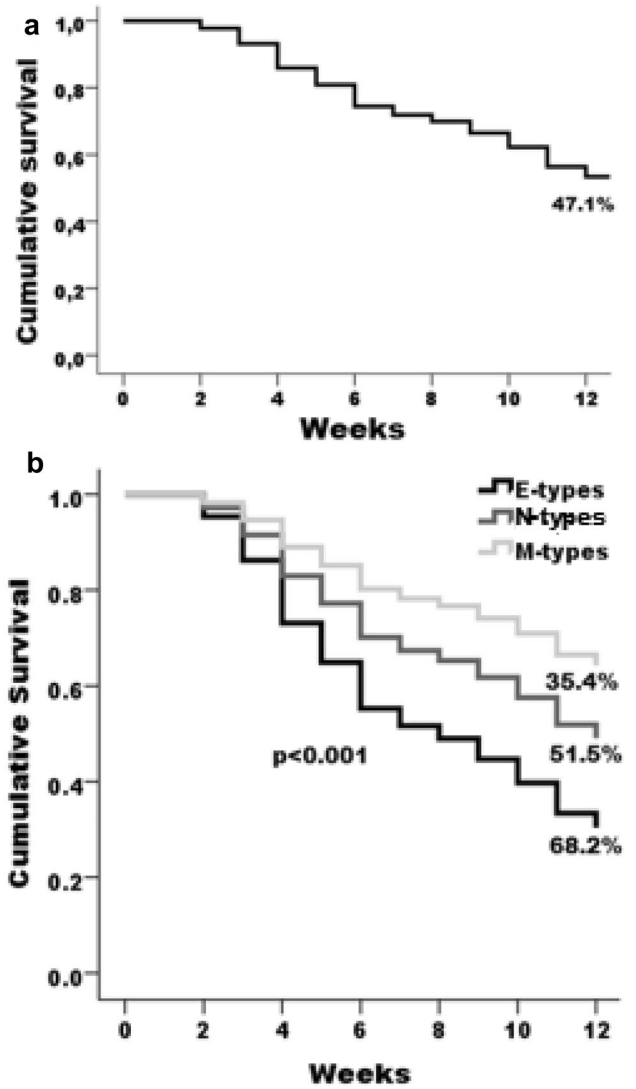

Fig. 1 **a** Survival curve for the sampled data across 12 weeks after gym enrollment. **b** Survival curve for the sample data distributed between three chronotype groups

The confounding variables were the same in the two multivariate models: age, educational level, civil status, duration of membership plan and exercise frequency in week 1. The exposure variable was chronotype, tested using the MEQ score (model 1) and chronotypes (model 2). The outcome variable, in both models, was dropout or not at week 12, according to the criteria described above.

Results

A total of 212 new members agreed to participate in our study, of which 59 were excluded: 51 did not answer the baseline questionnaire; 3 did not record their presence using the electronic ticketing gate; 2 were enrolled longer than the 2-week limit; 2 did not live in Curitiba and 1 was undergoing a chemical dependency recovery treatment. A final number of 153 subjects (72.2%) were followed up and included in the study.

Tables 1 (qualitative variables) and 2 (quantitative variables) present the sample general characteristics according to the dropout of physical exercise programs within 12 weeks. The sample was composed of adults with mean age and body mass index of 33.6 (± 11.9) years and 26.0 (± 4.5) kg/m^2, respectively. Most of them were female (66.7%), working (83.7%), single (53.6%) and had no children (68%). Regarding chronotype, the largest part of the population was N-types (43.1%), followed by M-types (42.5%), the smallest part being E-types (14.4%).

After 12 weeks, 47.1% of the gym members had dropped out from their physical exercise programs (Fig. 1a). Considering their chronotype (Fig. 1b), 68.2% were E-types, 51.5% were N-types and 35.4% were M-types ($p < 0.001$).

The two multivariate models generated are presented in Table 3. The multivariate model 1 shows that acquiring a monthly membership plan was associated with higher dropout risk compared to acquiring an annual membership plan (HR = 2.36; CI95% 1.32–4.24; $p < 0.001$). Higher practice frequency during the first week was associated with lower dropout risk (HR = 0.70; CI95% 0.58–0;85; $p < 0.001$). Even after adjusting for possible confounding variables, higher MEQ score was associated with lower chance of dropping out from the program (HR = 0.98; CI95% 0.95–1.00; $p = 0.046$). When considering three chronotypes, multivariate model 2, E-types had the highest dropout risk compared to M-types (HR = 2.22; CI95% 1.09–4.52; $p = 0.027$).

Table 1 Sample characteristics (qualitative variables)

Variables	Total		Dropouts		Adherents		Crude analysis	
	n	%	*n*	%	*n*	%	HR	CI95%
Total	153	100.0	72	47.1	81	52.9	–	–
Demographic characteristics								
Sex								
Male	51	33.3	24	47.1	27	52.9	1.02	(0.63–1.67)
Female	102	66.7	48	47.1	54	52.9	1.00	
Educational level								
Up to high school graduate	68	44.4	38	55.9	30	44.1	2.06*	(1.11–3.80)
Bachelor's graduate	44	28.8	20	45.5	24	54.5	1.35	(0.68–2.67)
Completed postgraduation	41	26.8	14	34.1	27	65.9	1.00	
Civil status								
Single	82	53.6	44	53.7	38	46.3	1.63*	(1.01–2.62)
Married/stable union	71	46.4	28	39.4	43	60.6	1.00	(0.60–3.25)
Number of children < 18 yo								
0	104	68	48	46.2	56	53.8	1.39	(0.69–4.39)
1	33	21.6	18	54.5	15	45.5	1.74	(0.96–1.00)
2 or more	16	10.5	6	37.5	10	62.5	1.00	
Health characteristics								
Presence of chronic disease								
None	126	85.7	56	44.4	70	55.6	0.64	(0.35–1.17)
1 or more	21	14.3	13	61.9	8	38.1	1.00	
Tobacco usage								
No	143	93.5	67	46.9	76	53.1	1.05	(0.42–2.59)
Yes	10	6.5	5	50	5	50	1.00	
PA characteristics or associated with gym								
PA total								
< 600 met-min per week	32	20.9	13	40.6	19	59.4	0.73	(0.40–1.32)
> = 600 met-min per week	121	79.1	59	48.8	62	51.2	1.00	
Duration of membership plan								
1 month	47	30.9	30	63.8	17	36.2	2.63*	(1.49–4.64)
3 months to 6 months	44	28.9	21	47.7	23	52.3	1.55	(0.84–2.85)
Annual	61	40.1	20	32.8	41	67.2	1.00	
Chronobiological and sleep characteristics								
Chronotypes								
E-types	22	14.4	15	68.2	7	31.8	1.00	
N-types	66	43.1	34	51.5	32	48.5	0.60	(0.33–1.10)
M-types	65	42.5	23	35.4	42	64.6	0.37*	(0.19–0.71)
Social jetlag categorized (h)								
Up to 1 h	48	31.4	22	45.8	26	54.2	0.79	(0.42–1.47)
Between 1 and 2 h	63	41.2	28	44.4	35	55.6	0.79	(0.44–1.43)
> 2 h	34	22.2	18	52.9	16	47.1	1.00	
PSQI categorized (score)								
Good sleepers	81	52.9	37	45.7	44	54.3	0.85	(0.54–1.36)
Bad sleepers	72	47.1	35	48.6	37	51.4	1.00	

yo years old, *PA* physical activity, *met-min* metabolic equivalent of task per minute, *PSQI* Pittsburg Sleep Quality Index

*$p < 0.05$

Table 2 Sample characteristics (quantitative variables)

Variables	Total	Dropouts	Adherents	Crude Analysis	
	Mean ± SD	Mean ± SD	Mean ± SD	HR	CI95%
Demographic characteristics					
Age (years)	33.6 ± 11.9	31.8 ± 11.8	35.3 ± 11.8	0.98*	(0.96–1.00)
PA characteristics or associated with gym					
Exercise frequency on week 1 (number of days)	3.1 ± 1.4	2.8 ± 1.3	3.5 ± 1.3	0.75*	(0.63–0.89)
Anthropometric characteristics					
BMI, (kg/m^2)	26 ± 4.5	26.6 ± 4.7	25.6 ± 4.4	1.04	(0.98–1.09)
Abdominal circumference (cm)	89.9 ± 11.3	90.9 ± 11.8	89.3 ± 10.6	1.01	(0.99–1.03)
Chronobiological and sleep characteristics					
Chronotype (MEQ score)	53.7 ± 11.0	50.7 ± 11.2	56 ± 10.6	0.97*	(0.95–0.99)
Sleep duration during workdays (h)	7.1 ± 1.1	7 ± 1.2	7.3 ± 1	0.86	(0.69–1.08)
Sleep duration during free days (h)	8.3 ± 1.3	8.2 ± 1.4	8.3 ± 1.2	1.01	(0.84–1.21)
PSQI (score)	6 ± 3.3	6.3 ± 3.4	5.5 ± 3.1	1.07	(1.00–1.14)

BMI body mass index, *MEQ* Morningness–Eveningness Questionnaire, *PSQI* Pittsburgh Sleep Quality Index

Table 3 Multivariate models expressing chronotype as (1) MEQ scores and (2) three chronotypes

Variables	Model 1			Model 2		
	HR	CI95%	*p*	HR	CI95%	*p*
Age (years)	0.99	(0.96–1.01)	0.37	0.99	(0.96–1.01)	0.35
Educational level						
Up to high school degree	1.75	(0.89–3.45)	0.11	1.73	(0.87–3.43)	0.12
Bachelor's degree	1.28	(0.64–2.55)	0.49	1.20	(0.60–2.43)	0.60
Complete graduate school (MSc/PhD)	1.00			1.00		
Civil status						
Single	0.79	(0.47–1.35)	0.39	0.77	(0.46–1.31)	0.34
Married/stable Union	1.00			1.00		
Duration of membership plan						
1 month	2.37	(1.33–4.24)	**< 0.001**	2.36	(1.32–4.24)	**< 0.001**
3 months to 6 months	1.66	(0.88–3.13)	0.12	1.72	(0.91–3.26)	0.10
Annual	1.00			1.00		
Frequency on week 1	0.70	(0.58–0.85)	**< 0.001**	0.70	(0.57–0.85)	**< 0.001**
Chronotype (MEQ score)	0.98	(0.95–1.00)	**0.046**			
Chronotypes						
E-types				2.22	(1.09–4.52)	**0.027**
N-types				1.19	(0.67–2.1)	0.05
M-types				1.00		

Statistically significant results in bold

Model 1 multivariate model for chronotype (MEQ score), *Model 2* multivariate model for three chronotypes, *MEQ* Morningness–Eveningness Questionnaire

Discussion

In this study, we show that the greater the tendency to eveningness, the higher the chance of dropping out from workout routines during a 12-week period. Even when adjusting the potential confounding variables such as age, marital status, educational level, duration of gyms memberships plan and frequency of workout on week 1, the chronotype still significantly predicted the outcome of physical exercise.

In our study, 47% of subjects dropped out over 12 weeks. When sorting out data by chronotype, 68.2% of E-types and 35.4% of M-types had quit in the mentioned period. This difference in the proportion of dropout rates

suggests higher difficulty of E-types to adhere to physical exercise routines in a formal context.

The gym's dropout rates among members in our study did not diverge from those in the literature, which showed large variation, possibly due to sociocultural and local factors [46, 48–51]. In a study conducted with 5240 members of a Brazilian gym, Sperandei et al. [50] verified 67% dropout rate in 3 months, whereas Gjestvang et al. [51] found 21% in the same period in Norwegian gyms. However, the latter believed that these numbers should be higher, as up to 30.4% of volunteers dropped out from the study in the first 3 months.

Many cross-sectional studies have found an association between eveningness and lower levels of total PA evaluated using subjective [22–30] and objective methods [13]. Hisler et al. [31] verified that chronotype predicts lower frequency of workout along 1 month of intentional physical exercise (defined by these authors as any physical exercise that the volunteer chose to practice). However, for the first time, we showed the directionality of the association between chronotype and physical activity as an outcome variable (expressed by participation in physical exercise programs), with subjective methods.

The fact that E-types dropped out earlier than M-types can help explain, partially, why E-types appear less physically active in cross-sectional studies. It may be that E-types, by quitting earlier, do not experience significant physiological and psychological benefits of regular PAs over the first 12 weeks [52, 53]. Evidence indicates that this period is critical for creating health habits [54] and especially physical exercise habits in gyms [37].

There is much evidence on the literature that eveningness people tend to have worse health conditions, with higher chances of presenting psychological, neurological, gastrointestinal and respiratory problems [55], higher risk of psychiatric diseases [56], larger metabolic and cardiovascular rates of dysfunctions [57], worse health habits [21, 58], less successful long-term weight loss maintenance [59], more sleep complaints [60] and higher mortality by all causes [55, 61], when compared to M-types. Considering all evidence, the higher dropout rates of E-types could be explained by differences in health conditions. In our sample, E-types showed worse sleep quality than M-types, not showing other differences in variables associated with health. However, sleep quality was not associated with the outcome of physical exercise up to week 12. Furthermore, the younger age distribution of E-types possibly reduced the chances of finding higher prevalence of non-communicable chronic diseases, since such pathologies, in general, develop in the long term.

A possible explanation for the lower risk of dropout by M-types might be personality differences. M-types tend to be more conscientious [62–64]. Conscientious people are prudent, reliable, organized, persistent, focused on accomplishing goals, seek more control over impulses and on complying with the standards; these lead to accomplishing and implementing actions that contribute to reaching established life objectives [64]. Hisler et al. [31] showed that conscientious people mediated the association between higher frequency of physical exercise, over 1 month, and morningness. In our study, personality was not assessed.

In addition to the chronotype, the main target of the hypothesis tested in this work, two variables related to the context of gyms robustly predicted the dropout of physical exercise programs at 12 weeks. The higher the exercise frequency in week 1, the lower is the risk of dropping out at week 12. We interpret that the exercise frequency in week 1 may reveal, at the same time, new gym members' motivation and the level of congruence between intention and action. In our study, we did not measure the volunteers' intention to exercise. Therefore, we cannot speculate how much the volunteers' intention level may be associated with exercise behavior, in the gym, in the first week.

Besides conscious intentions, understood as strong predictors of behavior [65], unconscious processes operate in parallel on behavior, acting as post-intentional factors [66]. A post-intentional factor that is also recognized as a predictor of exercise behavior is habit [67]. Looking from the point of view of the participation of unconscious processes in the formation of exercise habit, one of the factors postulated as important for habit formation is consistency [68]. Thus, a greater frequency of practice in week 1 minimally contributes as a repetition of the behavior and can "accelerate" the formation of unconscious processes related to the exercise habit. If this were indeed the case, greater motivation to persist in the following weeks could result from a more consistent practice in the first week, tending to become more automatic. Furthermore, we emphasize that the frequency of attendance to the gym in the earlier period (1–3 months) proved to be an important factor in predicting commitment to physical exercise over 1-year period [69], deserving more attention in future research.

Additionally, acquiring a monthly membership plan predicted higher risk of dropping out than acquiring an annual membership plan for 12 weeks. This did not occur when compared to those who acquired a 3-month to 6-month membership plan. Dellavigna et al. [70], while analyzing data from three American gyms, found that customers choose a contractual plan based on rational expectations of future practice. Therefore, in our study, individuals who opted for the annual plan could be more "willing/prepared" (financially, emotionally, temporally) to practice in these first months. Dellavigna et al. [70] showed that the average attendance in months 2, 3 and 4 was 10% higher under the annual contract than under the monthly contract of people who joined the gym. Regarding the dropout of exercise programs at the gym during this period, our data show that there

is an advantage in contracting the annual plan. However, it should be noted that people, as consumers, often create expectations that are not always consistent with their concrete situations, overestimating their attendance at the gym [70].

Sociodemographic variables, civil status and educational level, despite showing association with dropping out of workout routines, did not predict the risk of dropping out in the multivariate analyses. There is evidence that people with a greater number of years of education, compared to those with fewer years, had greater proportion of leisure-time physical activity (a domain of physical activity that includes the practice of exercise in gyms) in Brazil [71]. The educational level tends to be associated with purchasing power and economic status. Maybe the educational level classification in our study was not sensitive enough to detect significant differences in income, losing the association with the outcome variable in the multivariate models.

Finally, there are reports on the association between civil/marital status and PA in leisure time/exercise [72, 73]. Dias-da-Costa et al. [72], in a cross-sectional epidemiological study in southern Brazil, found that people living without a partner were associated with higher prevalence of physical activity in leisure time, compared with people living with a partner, in a fitted model. Although our data also indicate this trend in the bivariate analysis, it is possible that, in the context of gyms, other factors have a greater weight in relation to the outcome variable of this study.

Strengths

In this study, we objectively measured exercise behavior using records from the gym's electronic turnstiles. This measure is trustworthy since the selected gyms did not offer any other services that could encourage people to pass through the electronic turnstiles—therefore, it can be taken as a sign that they were there to perform physical exercises. Furthermore, the research team made face-to-face shifts at the gyms for 10 months, at different times (morning, afternoon and evening), to recruit volunteers. During this whole period, the passage of members through the turnstile without going to exercise was never observed.

Our results come from a real context, outlining the impact of individual chronotype on workout routines, considering social obligations such as work, school and family.

Limitations.

We did not reach the calculated n for this research. Based on the dropout ratio reported for week 12 by Sperandei et al. [50], the required sample size was 243 volunteers. We did not attain this number, as we had to stop data collection in March 2020 due to the COVID-19 pandemic. We would have another 5 months to recruit new volunteers. Even so, the power of our sample size, for the logistic regression test using the G-power program [74], ($n = 153$), for alpha of 0.05, with a risk ratio of 2.2 (exposure variable), was 0.98, which is considered optimal.

We did not objectively evaluate the PA levels before gym enrollment. As voluntary recruitment occurred in real time, people had already begun or were starting gym routines when contacted. Therefore, this could skew the individual prediction of dropping out with this variable, which was not significant. This way, if there were striking differences in PA rates before enrollment, and if they could predict dropout, such effect would not have been possible to observe.

Although self-efficacy and social support did not predict dropout in our study (data not reported), it may be that the use of more detailed scales, such as those used by Golaszewski et al. [75] with different forms of social support, could yield other results. The fact that we did not measure other psychosocial variables, such as intention, exercise identity and motivation, also limits our conclusions.

The activities were not supervised by the researchers, but by the physical education professionals present in the gyms. Although there is a possibility that some participants may go to the gym without performing their training, we believe this is unlikely.

More studies should be conducted to understand whether there are social factors, such as working hours, associated with higher dropout rates among E-types. Studying psychosocial aspects such as tastes and preferences for PA, motivation for PA could help to understand the higher rates of dropout found in E-types. Finally, in additional studies, it would be important to supervise the physical exercise programs performed, their intensity, type and duration and verify if they meet physical activity recommendations for health.

Conclusion

Our results suggest that chronotype is another variable to be considered in future studies on promoting PAs in formal environments, especially considering the evening population, more vulnerable to morbidity. Membership plans proved to be important in predicting dropout in the 12-week period. Finally, the frequency of practice in week 1 established robust evidence of prediction of dropout in the mentioned period, deserving more attention in additional studies.

Acknowledgements We are very grateful to the team of students who assisted in data collection and to CAPES and CNPQ for making this research feasible. We would like to thank iReview (a specialized company that provided this text translation into English), namely Dr. Nelson A M Lemos and Dr. Kleber M Mise, for their assistance. This work was funded by the authors themselves.

Funding Doctoral scholarship funding from CAPES/FUNDAÇÃO ARAUCÁRIA, project number 88882.168537/2018-01 to Flávio

Augustino Back and PIBIC CAPES scholarships to Wilynson Gomes Bojarski were provided.

Declarations

Conflict of interest The authors report that there are no competing interests to declare.

Ethics approval The authors declare that the procedures were followed according to the regulations established by Ethics Committee and to the Helsinki Declaration. The study was approved by the Ethics Committee for Research in Human Beings of the Federal University of Paraná (opinion 80184517.2.0000.0102, approved in 2018).

Informed consent Written consent was obtained from all participants prior to the start of study.

References

1. Sallis JF, Bull F, Guthold R, Heath GW, Inoue S, Kelly P et al (2016) Progress in physical activity over the Olympic quadrennium. Lancet 388(10051):1325–1336. https://doi.org/10.1016/S0140-6736(16)30581-5
2. Hallal PC, Bauman AE, Heath GW, Kohl HW, Lee IM, Pratt M (2012) Physical activity: more of the same is not enough. Lancet 380(9838):190–191. https://doi.org/10.1016/S0140-6736(12)61027-7
3. Bull FC, Al-Ansari SS, Biddle S, Borodulin K, Buman MP, Cardon G et al (2020) World Health Organization 2020 guidelines on physical activity and sedentary behaviour. Br J Sports Med 54(24):1451–1462
4. Katzmarzyk PT, Friedenreich C, Shiroma EJ, Lee IM (2021) Physical inactivity and non-communicable disease burden in low-income, middle-income and high-income countries. Br J Sports Med 56(2):101–106
5. Owen N, Healy GN, Matthews CE, Dunstan DW (2010) Too much sitting: the population-health science of sedentary behavior. Exerc Sport Sci Rev 38(3):105–113
6. Hadgraft N, Owen N (2017) Sedentary behavior and health: broadening the knowledge base and strengthening the science. Res Q Exerc Sport 88(2):123–129. https://doi.org/10.1080/02701367.2017.1305257
7. Caspersen CJ, Powell KE, Christenson GM (1985) Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public Heal Rep 100(2):126–131
8. Ekelund U, Steene-Johannessen J, Brown WJ, Fagerland MW, Owen N, Powell KE et al (2016) Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? A harmonised meta-analysis of data from more than 1 million men and women. Lancet 388(10051):1302–1310. https://doi.org/10.1016/S0140-6736(16)30370-1
9. Youngstedt SD, Elliott JA, Kripke DF (2019) Human circadian phase–response curves for exercise. J Physiol 597(8):2253–2268
10. Thomas JM, Kern PA, Bush HM, McQuerry KJ, Black WS, Clasey JL et al (2020) Circadian rhythm phase shifts caused by timed exercise vary with chronotype. JCI Insight. https://doi.org/10.1172/jci.insight.134270
11. Moreno CRC, Wright K, Skene DJ, Louzada FM (2020) Phenotypic plasticity of circadian entrainment under a range of light conditions. Neurobiol Sleep Circadian Rhythm 9:100055. https://doi.org/10.1016/j.nbscr.2020.100055
12. Roenneberg T, Kumar CJ, Merrow M (2007) The human circadian clock entrains to sun time. Curr Biol 17(2):44–45
13. Nauha L, Jurvelin H, Ala-Mursula L, Niemelä M, Jämsä T, Kangas M et al (2020) Chronotypes and objectively measured physical activity and sedentary time at midlife. Scand J Med Sci Sport 30(10):1930–1938
14. Horne JA, Ostberg O (1976) A self-assessment questionnaire to determine morningness–eveningness in human circadian rhythms. Int J Chronobiol 4(2):97–110
15. Montaruli A, Galasso L, Caumo A, Cè E, Pesenti C, Roveda E et al (2017) The circadian typology: the role of physical activity and melatonin. Sport Sci Health 13(3):469–476
16. Bailey SL, Heitkemper MM (1991) Morningness–eveningness and early-morning salivary cortisol levels. Biol Psychol 32(2–3):181–192
17. Duffy J, Dijk D, Hall E, Czeisler C (1999) Relationship of endogenous circadian melatonin and temperature rhythms to self-reported preference for morning or evening activity in young and older people. J Investig Med 47(3):141–150
18. Baehr E, Revelle W, Eastman C (2000) Individual differences in the phase and amplitude of the human circadian temperature rhythm: with an emphasis on morningness–eveningness: phase and amplitude of the temperature rhythm. J Sleep Res 9(2):117–127
19. Duffy JF, Rimmer DW, Czeisler CA (2001) Association of intrinsic circadian period with morningness–eveningness, usual wake time, and circadian phase. Behav Neurosci 115(4):895–899
20. Adan A, Archer SN, Hidalgo MP, Di ML, Natale V, Randler C (2012) Circadian typology: a comprehensive. Review 29(9):1153–1175
21. Fabbian F, Zucchi B, De Giorgi A, Tiseo R, Boari B, Salmi R et al (2016) Chronotype, gender and general health. Chronobiol Int 33(7):863–882
22. Schaal S, Peter M, Randler C (2010) Morningness–eveningness and physical activity in adolescents. Int J Sport Exerc Psychol 8(2):147–159
23. Urbán R, Magyaródi T, Rigó A (2011) Morningness-eveningness, chronotypes and health-impairing behaviors in adolescents. Chronobiol Int 28(3):238–247
24. Ramin C, Devore EE, Pierre-Paul J, Duffy JF, Hankinson SE, Schernhammer ES (2013) Chronotype and breast cancer risk in a cohort of US nurses. Chronobiol Int 30(9):1181–1186
25. Haraszti RÁ, Purebl G, Salavecz G, Poole L, Dockray S, Steptoe A (2014) Morningness–eveningness interferes with perceived health, physical activity, diet and stress levels in working women: a cross-sectional study. Chronobiol Int 31(7):829–837
26. Mota MC, Waterhouse J, De-Souza DA, Rossato LT, Silva CM, Araújo MBJ et al (2016) Association between chronotype, food intake and physical activity in medical residents. Chronobiol Int 33(6):730–739
27. Suh S, Yang HC, Kim N, Yu JH, Choi S, Yun CH et al (2017) Chronotype differences in health behaviors and health-related quality of life: a population-based study among aged and older adults. Behav Sleep Med 15(5):361–376
28. Vera B, Dashti HS, Gómez-Abellán P, Hernández-Martínez AM, Esteban A, Scheer FAJL et al (2018) Modifiable lifestyle behaviors, but not a genetic risk score, associate with metabolic syndrome in evening chronotypes. Sci Rep 8(1):1–11
29. Castelli L, Galasso L, Mulè A, Bruno E, Shokohyar S, Esposito F et al (2019) Physical activity, chronotype and sleep in a sample of Italian elderly population. Sport Sci Health. https://doi.org/10.1007/s11332-019-00573-x
30. Oliveira GF, Marin TC, Apolinário N, Rosa-Silva J, Azevêdo L, Ceciliato J et al (2021) Association of morningness–eveningness preference with physical activity during the COVID-19 pandemic social distancing: a cross-sectional survey in Brazil: Circadian

rhythm, physical activity and isolation. Chronobiol Int. https://doi.org/10.1080/07420528.2021.1931276
31. Hisler GC, Phillips AL, Krizan Z (2016) Individual differences in diurnal preference and time-of-exercise interact to predict exercise frequency. Ann Behav Med 51(3):391–401. https://doi.org/10.1007/s12160-016-9862-0
32. Wennman H, Kronholm E, Partonen T, Peltonen M, Vasankari T, Borodulin K (2015) Evening typology and morning tiredness associates with low leisure time physical activity and high sitting. Chronobiol Int 32(8):1090–1100
33. Sherwood NE, Jeffery RW (2000) The behavioral determinants of exercise: implications for physical activity interventions. Annu Rev Nutr 20:21–44
34. Rhodes RE, Plotnikoff RC, Courneya KS (2008) Predicting the physical activity intention-behavior profiles of adopters and maintainers using three social cognition models. Ann Behav Med 36(3):244–252
35. Koeneman MA, Verheijden MW, Chinapaw MJM, Hopman-Rock M (2011) Determinants of physical activity and exercise in healthy older adults: a systematic review. Int J Behav Nutr Phys Act 8:1–15
36. Bauman AE, Reis RS, Sallis JF, Wells JC, Loos RJF, Martin BW et al (2012) Correlates of physical activity: Why are some people physically active and others not? Lancet 380(9838):258–271. https://doi.org/10.1016/S0140-6736(12)60735-1
37. Kaushal N, Rhodes RE (2015) Exercise habit formation in new gym members: a longitudinal study. J Behav Med 38(4):652–663. https://doi.org/10.1007/s10865-015-9640-7
38. Benedito-silva AA, Menna-barreto L, Alam MF, Rotenberg L, Moreira LFS, Menezes AAL et al (1990) Latitude and social habits as determinants of the distribution of morning and evening types in Brazil. Biol Rhythm Res 29(5):591–597
39. Roenneberg T, Wirz-Justice A, Merrow M (2003) Life between clocks: daily temporal patterns of human chronotypes. J Biol Rhythms 18(1):80–90
40. Reis C, Madeira SG, Lopes LV, Paiva T, Roenneberg T (2020) Validation of the Portuguese Variant of the Munich Chronotype Questionnaire (MCTQPT). Front Physiol 11(July):1–10
41. Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ (1989) The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res 28:193–123
42. Bertolazi AN, Fagondes SC, Hoff LS, Dartora EG, da Silva Miozzo IC, de Barba MEF et al (2011) Validation of the Brazilian Portuguese version of the Pittsburgh Sleep Quality Index. Sleep Med 12(1):70–5. https://doi.org/10.1016/j.sleep.2010.04.020
43. Matsudo S, Araújo T, Matsudo V, Andrade D, Andrade E, Oliveira LC et al (2001) Questionário Internacional De Atividade Física (Ipaq): Estupo De Validade E Reprodutibilidade No Brasil. Rev Bras Atividade Física Saúd 6(2):5–18. https://periodicos.ufpel.edu.br/ojs2/index.php/RBAFS/article/view/931
44. Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE et al (2003) International physical activity questionnaire: 12-Country reliability and validity. Med Sci Sports Exerc 35(8):1381–1395
45. Annesi JJ (2003) Effects of a cognitive behavioral treatment package on exercise attendance and drop out in fitness centers. Eur J Sport Sci 3(2):1–16
46. Annesi JJ, Otto LM (2004) Relationship between number of exercise counseling sessions attended and adherence to a new exercise program. Psychol Rep 94(3I):907–8
47. Annesi JJ (2007) Effects of a computer feedback treatment and behavioral support protocol on drop out from a newly initiated exercise program. Percept Mot Skills 105(1):55–66
48. Dishman R, Sallis J, Orentein D (1985) The determinants of physical activity andexercise. Public Heal Rep 100(2):158–71
49. Clavel San Emeterio I, García-Unanue J, Iglesias-Soler E, Luis Felipe J, Gallardo L (2019) Prediction of abandonment in Spanish fitness centres. Eur J Sport Sci 19(2):217–24. https://doi.org/10.1080/17461391.2018.1510036
50. Sperandei S, Vieira MC, Reis AC (2016) Adherence to physical activity in an unsupervised setting: explanatory variables for high attrition rates among fitness center members. J Sci Med Sport 19(11):916–20. https://doi.org/10.1016/j.jsams.2015.12.522
51. Gjestvang C, Stensrud T, Haakstad LAH (2019) Are changes in physical fitness, body composition and weight associated with exercise attendance and dropout among fitness club members? Longitudinal prospective study. BMJ Open 9(4):1–10
52. Di Corrado D (2017) Biological underpinnings of mood and the role of physical exercise. Sport Sci Health 13(3):461–468
53. Kubo K, Ikebukuro T, Yata H, Tsunoda N, Kanehisa H (2010) Time course of changes in muscle and tendon properties during strength training and detraining. J Strength Cond Res 24(2):322–331
54. Lally P, Van Jaarsveld CHM, Potts HWW, Wardle J (2010) How are habits formed: modelling habit formation in the real world. Eur J Soc Psychol Eur 40:998–1009
55. Knutson KL, von Schantz M (2018) Associations between chronotype, morbidity and mortality in the UK Biobank cohort. Chronobiol Int 35(8):1045–53. https://doi.org/10.1080/07420528.2018.1454458
56. Antypa N, Vogelzangs N, Meesters Y, Schoevers R, Penninx BWJH (2016) Chronotype associations with depression and anxiety disorders in a large cohort study. Depress Anxiety 33(1):75–83
57. Merikanto I, Lahti T, Puolijoki H, Vanhala M, Peltonen M, Laatikainen T et al (2013) Associations of chronotype and sleep with cardiovascular diseases and type 2 diabetes. Chronobiol Int 30(4):470–477
58. De Amicis R, Galasso L, Leone A, Vignati L, De Carlo G, Foppiani A et al (2020) Is abdominal fat distribution associated with chronotype in adults independently of lifestyle factors? Nutrients 12(3):1–9
59. Ross KM, Graham Thomas J, Wing RR (2016) Successful weight loss maintenance associated with morning chronotype and better sleep quality. J Behav Med 39(3):465–471
60. Merikanto I, Kronholm E, Peltonen M, Laatikainen T, Lahti T, Partonen T (2012) Relation of chronotype to sleep complaints in the general finnish population. Chronobiol Int 29(3):311–317
61. Broms U, Pitkaniemi J, Backmand H, Heikkila K, Koskenvuo M, Peltonen M et al (2013) Long-term consistency of diurnal-type preferences among men. Chronobiol Int 32(2):182–188
62. Lipnevich AA, Credè M, Hahn E, Spinath FM, Roberts RD, Lipnevich AA et al (2016) How distinctive are morningness and eveningness from the big five factors of personality? A meta-analytic investigation. J Pers Soc Psychol 15:1–19
63. Tsaousis I (2010) Circadian preferences and personality traits: a meta-analysis. Eur J Pers 24:356–373
64. Friedman HS, Kern ML (2014) Personality, well-being, and health*. Annu Rev Psychol 65:719–742
65. Rhodes RE, Quinlan A (2015) Predictors of physical activity change among adults using observational designs. Sport Med 45(3):423–441
66. Rhodes RE, Yao CA (2015) Models accounting for intention-behavior discordance in the physical activity domain: a user's guide, content overview, and review of current evidence. Int J Behav Nutr Phys Act. https://doi.org/10.1186/s12966-015-0168-6
67. Kaushal N, Rhodes RE, Spence JC, Meldrum JT (2017) Increasing physical activity through principles of habit formation in new gym members: a randomized controlled trial. Ann Behav Med 51(4):578–586
68. Lally P, Gardner B (2013) Promoting habit formation. Health Psychol Rev 7(SUPPL1):37–41

69. Yi S, Lee YW, Connerton T, Park CY (2020) Should I stay or should I go? Visit frequency as fitness centre retention strategy. Manag Sport Leis 26(4):268–86. https://doi.org/10.1080/23750472.2020.1763829
70. DellaVigna S, Malmendier U (2006) Paying not to go to the gym. Am Econ Rev 96(3):694–719
71. de Ferrari GLM, Kovalskys I, Fisberg M, Gómez G, Rigotti A, Sanabria LYC et al (2020) Socio-demographic patterning of objectively measured physical activity and sedentary behaviours in eight Latin American countries: findings from the ELANS study. Eur J Sport Sci 20(5):670–81. https://doi.org/10.1080/17461391.2019.1678671
72. Porch TC, Bell CN, Bowie JV, Usher T, Kelly EA, Laveist TA et al (2016) The role of marital status in physical activity among African American and White Men. Am J Mens Heal 10(6):526–32
73. Dias-da-Costa JS, Hallal PC, Wells JCK, Daltoé T, Fuchs SC, Menezes AMB et al (2005) Epidemiology of leisure-time physical activity: a population-based study in southern Brazil. Cad saúde pública / Ministério da Saúde, Fundação Oswaldo Cruz, Esc Nac Saúde Pública 21(1):275–282
74. Erdfelder E, Faul F, Buchner A, Lang AG (2009) Statistical power analyses using G*Power 3.1: tests for correlation and regression analyses. Behav Res Methods 41(4):1149–60
75. Golaszewski NM, LaCroix AZ, Hooker SP, Bartholomew JB (2021) Group exercise membership is associated with forms of social support, exercise identity, and amount of physical activity. Int J Sport Exerc Psychol. https://doi.org/10.1080/1612197X.2021.1891121