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Patterns of physical activity and sedentary behavior associated with overweight in brazilian adolescents

Padrões de atividade física e comportamento sedentário associados ao excesso de peso em adolescentes brasileiros

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ABSTRACT

The scope of this study was to identify patterns of physical activity and sedentary behavior (PPASB) in adolescents enrolled in public schools and assess possible relationships between these patterns and overweight. This is a Cross-sectional study conducted in 2009, with the representative sample of adolescents enrolled in the fifth grade in public schools of Piracicaba, São Paulo (Brazil) consisted of 454 adolescents between 10 and 14 years of age. Physical activity, sedentary behavior and food intake information was collected through questionnaires. Anthropometric data were also collected (body mass and height). PPASB were identified through Principal Component Analysis. To characterize the association between PPASB and overweight, multiple binary logistic regression models were used. Out of 454 adolescents, 53.5% were female and 36.6% were overweight. Six PPASB were identified: 1) composed by volleyball and dance; 2) composed by soccer, video-game and computer; 3) composed by television and computer; 4) composed by dodge-ball and cycling; 5) composed by walking activity and 6) composed by gymnastics. The PPASB characterized by sedentary activities (television and computer) was associated with overweight (OR: 1.22, 95% CI: 1.02 - 1.46) after adjusted by sexual maturity, energy density and gender. In conclusions, taking a PPASB characterized mainly by spent time in front of the television and computer increases the chance of developing overweight.

KEYWORDS

Adolescents; Physical activity; Sedentary behavior; Principal component analysis; Overweight.

RESUMO

O objetivo do estudo foi identificar os padrões de atividade física e comportamento sedentário (PAFCS) de adolescentes de escolas públicas e verificar possíveis relações entre estes padrões e o excesso de peso corporal. Trata-se de um estudo transversal realizado em 2009, com amostra representativa dos adolescentes do 5º ano de escolas públicas de Piracicaba, São Paulo, constituída por 454 adolescentes de ambos os sexos com idade entre 10 e 14 anos. Por meio de questionários foram coletadas informações sobre atividade física, comportamento sedentário e consumo alimentar. Também foram coletados dados antropométricos (peso corporal e estatura). Os PAFCS foram identificados por meio da Análise de Componentes Principais. Para caracterizar a associação entre os PAFCS e o excesso de peso foram usados modelos de regressão logística binária múltipla. 53,5% eram meninas e 36,6% apresentaram excesso de peso. Seis padrões foram identificados: 1) composto por voleibol e dança; 2) composto por futebol, vídeo-game e computador; 3) composto por televisão e vídeo-game; 4) composto por queimada e ciclismo; 5) composto por caminhada; 6) composto por ginástica. O PAFCS caracterizado por atividades sedentárias (televisão e computador) foi associado ao excesso de peso (OR:1,22; 95% IC:1,02 - 1,46) depois de ajustado para maturação sexual, densidade energética e sexo Em conclusão, os adolescentes que possuem um padrão caracterizado principalmente por maior tempo gasto em frente a televisão e ao computador possuem uma maior chance de desenvolver excesso de peso.

PALAVRAS-CHAVE

Adolescentes; Atividade física; Comportamento sedentário; Excesso de peso; Análise de componentes principais.

INTRODUCTION

The cause for overweight development in children and adolescents, in several countries, may be considered multifactorial[1]. As an example of these factors we can mention genetic predisposition, physical inactivity, eating behavior with inappropriate dietary patterns and various environmental factors[2]. Overweight in adolescence may alter the health conditions and trigger the development of noncommunicable chronic diseases both in adolescence and in adulthood.

Acting effectively to change lifestyles has been one of the most evident ways to prevent overweight, especially changes in the practice of physical activity[3] (PA), although some results are still controversial as to the types of PA recommended, its intensity and frequency[4]. However, studies observed elevated prevalence of physical inactivity and sedentary behaviors (lengthy screen time or TV use) among adolescents[5].

The practices of PA and sedentary behavior have been used as markers of healthy and unhealthy habits in adolescents, respectively. A recent study shows that physical active adolescents also have better eating habits while those who spend more time watching television, computer and video games tend to have worse eating habits[5].

Thus, new statistical methods have been proposed to determine patterns of behavior which mix PA, sedentary behavior and lifestyle[6]. Promising statistical methods in epidemiology, such as the Principal Component Analysis, which is a method of multivariate analysis, have been used to identify patterns of PA and sedentary behavior[6,7], and the relationship of these patterns with obesity[7]. An important advantage of the Principal Components Analysis is that it allows to evaluate how PA from different domains correlates in a given population, not only studying each one separately as well as allows to merge different behaviors and lifestyle variables.

Since PA is an important tool for prevention and treatment of overweight, and the sedentary behavior is related to non-communicable chronic diseases in this age group, the aim of this paper is to identify Patterns of Physical Activity and Sedentary Behavior (PPASB) in Brazilians adolescents from public schools and assess possible relationships between these patterns and overweight.

METHODS

Sample and Design

This work is part of the study entitled "Factors affecting the risk of obesity in adolescents from public schools in Piracicaba: a cross-sectional study as a first step of a cohort study" funded by FAPESP (Grant #2006/61085-0, São Paulo Research Foundation).

In the present study, male and female adolescents older than 10 years, enrolled in the fifth grade in elementary school, and attending public schools in various regions of Piracicaba, São Paulo were included in our cross-sectional study.

To calculate the sample size, the following information was considered: 20% prevalence of overweight children; significance level of 5% and precision of 10%. The sampling procedure was simple random type, stratified by classes, being held in two stages. In first stage, all public schools with fifth grade classes (45 public schools), distributed throughout six regions of the city,

including in rural areas, were considered. We needed to sample a minimum of 26 schools. The number of schools selected in each region was proportional to its size. In the second stage of sampling, the classes were randomly selected by simple random sampling, within each of the 26 schools. To each selected class, there was a drawing for a number of students. The random draw was performed in a systematic manner; random numbers were drawn to select a student and potential alternatives in case the selected student did not meet the study inclusion criteria. Assuming a remission rate of 20%, a total 488 students were calculated to be necessary for the final sample size.

Assessment of nutritional status, PA and sedentary behavior

Body weight was obtained on an electronic scale (Tanita®), platform type. Height was measured with the aid of a rigid stadiometer (Alturaexata®). From these measures we calculated the body mass index (BMI) and adolescents were classified according to their nutritional status (cut-offs - normal weight < 85th; preobese: 85th to 96th; obese: ≥ 97th), using as reference curves of the WHO, 2007[8]. In the present study, adolescents with BMI below the 85th percentile were considered normal weight, and those with BMI above or equal to 85th percentile were considered overweight

The PA data were collected using a validated questionnaire called "Questionnaire for Adolescents Computerized Version" - (QACV)[9]. This questionnaire assesses habitual PA and sedentary behavior for the 12 months prior. When answering the questionnaire the adolescents reported 14 types of physical activities (soccer, indoor soccer, swimming, volleyball, basketball, handball, martial arts, dance, gymnastics, dodge-ball, adventure sports, cycling, games e travel). For each type of activity was obtained information on weekly frequency and time per day. Through the questionnaire we also evaluated the time and the weekly frequency of 3 sedentary activities such as watching television (TV), using the computer (PC) and playing video games (VG). With these data we determined the weekly time (minutes) for each activity. All variables mentioned by the adolescents (totaling 17 variables) through the questionnaire were included in the analysis.

After collecting the PA data was generates a final score in minutes (weekly) that was used as a continuous variable (minutes of PA) and as a dichotomous variable categorized as insufficiently active (<300min/wk) and active (≥300min/wk)[10].

Covariates

The level of sexual maturation was measured by a self-assessment of the stage of puberty, according to Tanner's worksheet[11]. The adolescents were classified as prepubertal and pubertal.

In QACV there was a question to collect information about sex variable. This variable was categorized into male and female.

Dietary intake was assessed through the application of a computerized Simplified Food Frequency Questionnaire for Adolescents[12]. To calculate energy density (kcal/g), we used a method that included all solid foods and beverages containing calories[13].

Statistical Analysis

For descriptive analysis we used measures of central tendency and dispersion.

The test was used to evaluate the value adherence for the continuous quantitative variables with normal distribution.

Principal Component Analysis was used to identify the PPASB. The main purpose of the Principal Components Analysis is to reduce an initial set of variables to a smaller number of variables called constructs or latent variables obtained by linear combination of the initial variables.

We used the weekly time (minutes) for each activity (PA and sedentary behavior). In order to build the patterns all 14 variables of PA and the 3 variables of sedentary behavior were used in the PCA. The test Kaiser-Meyer-Olkin was performed for the 17 variables, to verify the correlations between them and to show were suitable for this type of analysis. We used three criteria to retain the components generated in the Principal Component Analysis and after identify them as PPASB: 1) the eigenvalues > 1; 2) the eigenvalues graphic and 3) the interpretability of the components. The orthogonal varimax rotation was used to verify independence between the components generated by the analysis and generate better interpretability on the components retained for final analysis. After the retention of the factors considering the above mentioned criteria, these were interpreted as PPASB. To characterize these patterns were considered the PA and sedentary behavior variables with factor loads greater than 0.35. The positive loads indicated that the PA or sedentary behavior variable was highly correlated with that pattern, while the negative loads indicated a negative correlation of the variable with the generated pattern. Were generated scores for each one the patterns extracted for each one individuals in the study.

We used multiple binary logistic regression models to verify possible relationships between overweight and the six PPASB identified. All models were adjusted by sexual maturation, energy density and sex. Overweight is a dichotomous dependent variable (BMI: < 85th percentile or ≥ 85th percentile), and PPASB is an dichotomous independent variable (PPASB: practices or not).

For all statistical analyzes of interest, we established a significance level of 5%. The statistical analysis of the study was performed with the aid of the computer software Statistics/Data Analysis Special Edition, version 1.0. This project was approved by the Ethics Committee of the School of Public Health/ University of São Paulo (Brazil), under research protocol # 1633.

RESULTS

Out of 488 students selected, 34 students did not present complete anthropometric, demographic our physical actives measurements. Therefore, 454 adolescents between 10 and 14 years of age were included in our sample. Among those students, 211 were boys (46.5% of the total sample) and 243 were girls (53.5%). Of the total sample 59.9% (n = 272) were insufficiently active (<300 min/wk), and 59.2% (n = 161) were female. Out of 454 adolescents, 36.6% were overweight, of which 15.6% were obese.

Table 1 shows the descriptive statistics of quantitative variables. It is observed that the PA time shows a statistically significant difference, which demonstrates that boys show a longer time of PA in minutes than the time shown by girls. We observe also that the average screen time of the boys is significantly higher than the one measured for the girls. However, it is noted

that when evaluating TV, VG and PC separately, there is statistically significant difference only for the VG time.

TABLE 1 – Measures of central tendency of demographic, dietary, anthropometric and physical activity variables of adolescents from public schools, according to sex. Piracicaba/Brazil, 2009.

Variables	General n = 454		Male n = 211		Female n = 243		*P*[a] Value
	Average (SD)	Median	Average (SD)	Median	Average (SD)	Median	
Age	11.0 (0.8)	11.0	11.2 (0.8)	11.0	11.0 (0.8)	11.0	0.003
BMI	19.2 (4.1)	18.2	18.8 (3.7)	18.0	19.5 (4.4)	18.4	0.301
Min PAW	302.4 (328.6)	200.0	365.8 (385.3)	270.0	247.4 (258.5)	160.0	<0.001
Min screen	1692.1 (1154.1)	1500.0	1801.5 (1160.5)	1560.0	1597.1 (1142.5)	1380.0	0.048
TVwk (minutes)	1321.9 (943.3)	1140.0	1330.5 (1110.0)	914.4	1314.4 (969.5)	1140.0	0.757
VGwk (minutes)	148.6 (295.2)	0.0	251.0 (371.3)	90.0	59.6 (162.3)	0.0	<0.001
PCwk (minutes)	221.6 (439.9)	60.0	220.0 (408.3)	30.0	223.0 (466.4)	60.0	0.692
Energetic density (kcal/g))	1.5 (0.2)	1.5	1.5 (0.2)	1.5	1.5 (0.2)	1.5	0.345

a Mann Whitney Test; BMI- Body Mass Index; Min PAW- Weekly physical activities in minutes; Min screen – screen minutes (TV, Computer, Video-game); TVwk- Weekly TV minutes; VGwk- Weekly video-game minutes; PCwk- Weekly computer minutes.SD- standard deviation.

To identify PPASB, we selected eight components with eigenvalues > 1.0, which explained 57.0% of the variability of the sample. Then, using the result of the eigenvalues graphic and the interpretability criterion, 6 components were retained for analysis.

TABLE 2 – Factor loads of six components with eigenvalues greater than 1, estimated by principal component analysis. Piracicaba/Brazil, 2009.

Variables	PPASB1	Variables	PPASB2	Variables	PPASB3	Variables	PPASB4	Variables	PPASB5	Variables	PPASB6
Volleyball	0.557	Video-game	0.482	Television	0.425	Cycling	0.602	Walking	0.647	Gymnastics	0.678
Dance	0.524	Soccer	0.431	Computer	0.350	Dodge-ball	0.540	Dance	0.301	Dodge-ball	0.189
Games	0.325	Computer	0.393	Bask/Hand	0.309	Games	0.230	Travel	0.278	Television	0.177
Travel	0.292	Volleyball	0.321	Games	0.230	Computer	0.091	Gymnastics	0.150	Bask/Hand	0.153
Gymnastics	0.110	Bask/Hand	0.292	Cycling	0.205	Volleyball	0.081	Bask/Hand	0.107	Soccer	0.121
Adventure sports	0.051	Dance	0.270	Martial Arts	0.202	Walking	0.053	Soccer	0.105	Swimming	0.088
Soccer	-0.007	Dodge-ball	0.238	Gymnastics	0.162	Bask/Hand	-0.015	Computer	0.102	Dance	0.085
Martial Arts	-0.012	Television	0.207	Adventure spor	0.119	Television	-0.019	Cycling	0.069	Cycling	0.062
Swimming	-0.063	Adventure spor	0.124	Travel	0.089	Travel	-0.041	Futsal	0.066	Travel	0.034
Cycling	-0.104	Martial Arts	0.093	Walking	-0.016	Dance	-0.055	Martial Arts	0.011	Video-game	0.026
Television	-0.106	Swimming	0.086	Dance	-0.026	Gymnastics	-0.081	Dodge-ball	-0.006	Martial Arts	0.016
Dodge-ball	-0.140	Walking	0.066	Video-game	-0.056	Adventure spor	-0.102	Adventure spor	-0.009	Volleyball	-0.022
Bask/Hand	-0.152	Games	0.042	Volleyball	-0.159	Video-game	-0.129	Volleyball	-0.062	Computer	-0.071
Walking	-0.167	Cycling	0.038	Dodge-ball	-0.241	Martial Arts	-0.182	Video-game	-0.189	Futsal	-0.116
Futsal	-0.181	Futsal	0.012	Futsal	-0.296	Swimming	-0.229	Television	-0.193	Games	-0.310
Video-game	-0.184	Travel	-0.087	Soccer	-0.329	Soccer	-0.239	Swimming	-0.330	Walking	-0.334
Computer	-0.215	Gymnastics	-0.143	Swimming	-0.365	Futsal	-0.306	Games	-0.404	Adventure sport	-0.433

PPASB: Patterns of Physical Activity and Sedentary Behavior. Component loading > 0,35 were show in bold. The Kaiser- Meyer-Olkin (KMO) test = 0,60

Table 2 shows the components, named later as PPASB, according to the load factors obtained by Principal Component Analysis.

PPASB 1 was characterized by activities such as volleyball and dance. PPASB 2 was characterized by both team sports (soccer) and sedentary activities (VG and PC). PPASB 3 had greater contribution of sedentary activities such as TV and PC. PPASB 4 had greater contribution of dodge-ball and cycling for leisure activities. PPASB 5 was characterized by walking activity. PPASB 6 was characterized by gymnastics.

Table 3 shows that the adolescent under PPASB 3 has a greater chance to develop overweight. The PPASB 1, 2, 4, 5 and 6 were not associated with overweight.

TABLE 3 – Odds ratio and confidence interval (95%) of overweight according to the patterns of physical activity and sedentary behavior (PPASB), adjusted by sexual maturity, energy density and gender. Piracicaba/Brazil, 2009.

	Overweight			
	Crude analysis		Adjusted analysis	
	Odds (CI95%)	p Value	Odds (CI95%)	p Value
[a]PPASB1	1.01 (0.86-1.20)	0.832	0.98 (0.83-1.15)	0.812
[b]PPASB2	1.10 (0.93-1.31)	0.243	1.11 (0.95-1.32)	0.179
[c]PPASB3	1.24 (1.03-1.50)	0.027	1.22 (1.02-1.46)	0.034
[d]PPASB4	1.07 (0.87-1.33)	0.522	1.06 (0.89-1.26)	0.493
[e]PPASB5	1.13 (0.93-1.38)	0.226	1.09 (0.91-1.32)	0.340
[f]PPASB6	0.84 (0.68-1.03)	0.101	0.92 (0.76-1.12)	0.429

[a]PPASB1- patterns of physical activity and sedentary behavior characterized by activities such as volleyball and dance; [b]PPASB2 - patterns of physical activity and sedentary behavior characterized by soccer, VG and PC; [c]PPASB3 - patterns of physical activity and sedentary behavior characterized by TV and PC, being inversely related to swimming; [d]PPASB4 - patterns of physical activity and sedentary behavior characterized by dodge-ball and cycling for leisure activities;
[e]PPASB5 - patterns of physical activity and sedentary behavior characterized by walking activity, being inversely related to games; [f]PPASB6 - patterns of physical activity and sedentary behavior characterized by gymnastics.

DISCUSSION

In this study, we observed a high prevalence of insufficiently active adolescents, and boys are significantly more active than girls. Other studies have also shown a high prevalence of insufficiently active adolescents and the highest level of PA by the boys[14,15]. According Manios et al. [16] this PA level difference between the sexes should not be attributed to physiological sex differences, but to cultural and social beliefs of parents and teachers who encourage boys more than girls to practice sports and PA in general.

We observed that boys have shown more screen time when compared to girls, however, when evaluating separately the sedentary activities, we only note a statistically significant difference in video game times, with the highest average for the boys. The same results were found by Costa and Assis[17] when assessing students aged 7 to 10 years old, in Florianopolis, Santa Catarina (Brazil). While the regular practice of leisure PA and active commuting represent healthy behavior, screen time has been associated with reduced PA[18], to unhealthy eating behavior[19] and obesity[20].

In regards to the relationship between screen time and low levels of PA in adolescents, one must interpret this result with caution, because in a cohort study of adolescents between 10 and 12 years of age in the city of Pelotas (Bra-

zil) it was found that while TV time was associated with higher prevalence of sedentary lifestyle, the computer time had no association with the PA level, and play video game for an hour or more was a protective factor to sedentary lifestyle[14]. Dumith et al.[21] recently found in the same cohort mentioned earlier that playing video games was positively associated with adequate levels of PA. In a systematic review performed by Melkevik et al.[22], there were also divergent and inconsistent results between studies that verify the relationship between PA and screen time.

The results mentioned above suggest that the activities related to sedentary behavior should be evaluated separately. In this study, after evaluating both the screen time and sedentary activities separately, no significant associations with PA level were observed. Although evidences on the subject are limited, it is understood that reducing screen time is an extremely important recommendation, as part of the time spent in sedentary activities could be used in healthier activities such as leisure PA.

In this study, we identified patterns that mix different types of PA and sedentary behaviors. Analyze these types of patterns allows you to enlarge understanding of the relationships between PA, sedentary behavior and overweight in adolescents. However, this type of analysis is still little explored.

The current work found that practicing the PPASB 3, which is characterized mainly by weekly minutes in front of the TV, increases the chance of developing overweight. Among the sedentary behaviors, studies have shown that especially the TV time is associated with obesity[20,23]. Two possible explanations for this effect are the relationship between TV time and unhealthy eating behaviors[22] and the relationship between TV time and sedentariness[18]. Unhealthy eating and sedentariness are important risk factors for overweight.

In the present study, we observed that the PPASB 5, characterized by walking which is classed as aerobic exercise, did not show association with weight excess. However, aerobic exercises can contribute to a healthy nutritional status. In a study by Eliakim et al.[24], with 38 girls aged between 15 and 17 years, it was found a significant reduction of subcutaneous fat and visceral fat in the group who participated in aerobic activities (running, walking, aerobics and games) for 5 weeks, 5 days a week for 120-150 minutes, when compared to control group.

One possible explanation for this pattern not to show an inverse association with overweight is the low or moderate intensity during walking, as it is observed that moderate to high intensity aerobic activity presents good results in reducing body fat.[25]

PPASB 6 is characterized by gymnastics which consisted of strengthening activities (e.g. weight lifting) and mixed activities involving aerobic and strengthening exercises (e.g. Step class). The exercises for muscle strengthening have several benefits for the treatment of obesity, among them one can mention the increase in energy expenditure both during and after exercise, considering that, in the recovery period, fat is also oxidized.

Lubans et al.[26] performed a study of 108 adolescents (average age = 15, SD = 0.7 years) divided into three groups: exercises with free weights group, exercises with elastic tube group and a control group. The muscle strengthening exercises (free weights and elastic tubing) were performed on two sets of 10 to 12 repetitions for 8 weeks. It was observed that both groups of action

significantly reduced body fat and increased muscle strength, when compared with control group (P <0.01 for all comparisons).

PPASB 1 and 4 show intermittent activities (volleyball and dodge-ball) and activities that can be practiced intermittently or continuously (cycling and dance). The intermittent activities that typically involve games have benefits for body fat loss because they are pleasurable and involve high-intensity activities. Tjonna et al.[27] showed that intermittent and high intensity exercises are more effective in reducing body fat when compared to the low or moderate intensity exercises.

PPASB 2 is a mixture of intermittent activity (soccer) and sedentary activities (VG and PC). Both the benefits of intermittent activity for body fat loss and the lack of association between computer and video games times with obesity were discussed earlier.

One possible explanation for the patterns involving aerobic, strengthening and intermittent activities not showing an inverse association with overweight is that there is an information bias, since adolescents with overweight may overestimate their level of PA, thus presenting the level of PA of eutrophic adolescents. In addition to information bias, reverse causality can occur in cross-studies, i.e., due to concerns with body image, adolescents with higher body mass index seek to do more PA to lose weight, presenting, at the collection period, the same level of PA presented by eutrophic adolescents.

It is noteworthy that practicing only one type of PA during leisure time may not be sufficient to maintain adequate body composition or for the treatment of obesity. For the adolescent's health, guidelines from the Department of Health and Human Services[28] recommend that they practice, in an enjoyable way, aerobic activities, strengthening exercises, sports and flexibility exercises. Thus it is clear the need to encourage adolescents to combine different types of physical activities to increase the chance of developing a healthy nutritional state in a safe and enjoyable way.

In the current study it was found that the active commuting to the school did not have any relevant representation in any of the patterns. It was noted that 55.5% of adolescents did not actively travel or spent less than 20 minutes per day on the way to and from school. This prevalence was higher than the one reported in the study by Santos et al.[29] (43%) conducted with adolescents from Pernambuco (Brazil), between 14 and 19 years of age. One possible explanation for the low participation in this type of activity is lack of traffic safety, as well as the lack of bicycle paths and bike racks at school.

This information is extremely important, because it is known that active travel to school has been linked positively to the overall level of PA in adolescents, whereas the greater the distance of displacement, the greater the chance this activity helps to reduce body fat. Moreover, in a recent systematic review and meta-analysis, it was found that active travel was associated with 11% reduction of cardiovascular risk[30].

One strong point of the study is that Principal Component Analysis is an important tool to analyze the interrelationship of leisure activities, commuting PA and sedentary behavior. Thus, it enables to better understand and interpret the behavior of adolescents regarding their PA and sedentariness. Furthermore, it was possible to investigate the relationship between the different combinations of activities (patterns) practiced by the adolescents and

overweight. On the other hand, cross-sectional studies are vulnerable to the reverse causality effect, and this is a limitation. To increase the chance of observing the effects caused by PPASB over time, it is suggested, for future research, the use of longitudinal studies. In addition, our study was limited by not including the socioeconomic variable in the analysis. Although all adolescents are public school students, there may be significant variation in socioeconomic status among adolescents.

According to the results found, it was observed the need to encourage students to reduce TV time, as the teenagers who practiced the pattern mainly characterized by the TV and PC time were more likely to develop overweight.

It is understood that the PPASB identified by Principal Component Analysis will enable the development and supervision of more feasible public strategies to prevent and treat overweight.

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