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Brazilians living with diabetes do not meet basic physical activity guidelines for health – a cross-sectional study

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ABSTRACT

Introduction and aim. The purpose of this study was to describe the profile of physical activity (PA) of Brazilian adults living with diabetes mellitus living in large Brazilian urban centers, as well as to determine whether the practice aligns with the physical activity guidelines recommended for people with diabetes.

Material and methods. Cross-sectional data were acquired from the 2020 Surveillance System for Risk and Protective Factors for Chronic Non-communicable Diseases, in which about 54,000 persons aged 18 and older in all Brazilian state capitals were contacted in a telephone survey. Participants reported on their engagement in recreational physical activity and active commuting to school and/or work in the three months preceding the interview, as well as the weekly frequency and duration of these activities. They also stated whether they were living with diabetes. A descriptive analysis was performed, and statistical significance was determined using Pearson's chi-squared test.

Results. In 2020, 7.9% of the population identified themselves living with diabetes. There was a greater frequency among older women and those with less education. Walking, water aerobics, and general gymnastics were the most common kinds of physical activity reported by people with diabetes. Moreover, over half of them (54.5%) were inactive, and 15% matched the physical activity criteria. The majority (90%) practiced PA for 30 minutes or more per day, while 87% of those who were active and exercised 1 to 2 times per week did not meet the requirements of the Ministry of Health.

Conclusion. In 2020, 7.9% of the population identified themselves as having diabetes. There was a higher frequency among older women and those with less schooling. In the sample as a whole, approximately 70% of people living with diabetes were inactive (54.5%) or did not meet the minimum BP recommendations for people with diabetes. The duration of each session seemed to be in line with the recommendations, however, the lack of regularity caused by the low weekly frequency meant that the minimum recommended target could not be achieved. Efforts involving the continued monitoring of people living with diabetes and counseling in Primary Health Care to opt for a more physically active life, seem to be promising acts for a healthier life, pending a definitive resolution to the disease.
Keywords. exercise, diabetes mellitus, health promotion, preventive medicine, public health

Introduction

Diabetes mellitus (DM) is a chronic illness with numerous etiologies that is defined by a rise in blood glucose concentrations that, over time, can harm the body, notably the heart, brain, eyes, kidneys, nerves, and blood vessels.[1] Diabetes is caused by a combination of genetic and environmental factors, and the risk increases with age, obesity, and physical inactivity.[2]

According to the Pan American Health Organization (PAHO) and the World Health Organization (WHO), diabetes will be responsible for around 333 million deaths globally by 2025, with 284 million of those fatalities occurring in poorer nations.[3] By 2035, 20 million additional cases are projected in Latin American countries, primarily among the lower-income population[4]. Brazil now has the fourth-largest number of people with diabetes in the world (9.4% of the population) that is responsible for roughly 54,000 fatalities every year.[5]

The term physical activity (PA) is a non-drug intervention for the control of diabetes and associated complications.[3] Physical activity is understood in this study as any physical movement produced by the skeletal muscles that result in an increase in energy expenditure beyond rest.[6] However, at some points in the text, the term "physical exercise" may appear, as this was also originally used in the Vigitel questionnaire to facilitate communication with the respondent.

The immediate and chronic alterations in insulin action on glucose metabolism are the most apparent effect of PA for people with diabetes.[7-9] Colosimo et al. found a higher decrease in glycated hemoglobin in the active (intervention) groups than in the control (inactive) groups in their systematic review and meta-analysis.[10] The American Diabetes Association and the American College of Sports Medicine both encourage PA to promote insulin cellular action and glucose management.[11] There is considerable evidence that greater levels of PA are related to a decreased risk of cardiovascular disease, improves self-esteem and independence, and lowers the probability of early all-cause mortality.[12-14]

The effects on insulin action in response to a single session of moderate PA are maximal up to 24 hours after the PA session and gradually decrease until it approaches baseline values 72 hours later.[15] The increase in glucose absorption by the muscles in non-diabetics is followed by an increase in glucose production by the liver, keeping blood glucose steady. Under the same conditions of exertion, the use

of blood glucose by active muscles in people with diabetes is often greater than the hepatic synthesis of glucose, resulting in a reduction in blood glucose.[15] As a result of the temporary nature of the alterations generated by PA in insulin activity, numerous organizations throughout the world advocate the PA practice for adults living with diabetes.[16-18]

To improve insulin cellular action, the American Diabetes Association and the American College of Sports Medicine recommend 30 minutes of moderate- to vigorous-intensity aerobic PA five days a week, for a total of 150 minutes each week. This should be carried out across at least three days per week, with no more than two consecutive days. Resistance exercises (weight training) of moderate to intense intensity should be conducted at least twice a week on non-consecutive days, in addition to aerobic activities.[19-21] The WHO recommendations for adults (18–64 years), include strong recommendations based on overall moderate-certainty evidence on weekly volumes of aerobic and muscle-strengthening physical activity. Many of the benefits of physical activity are observed within average weekly volumes of 150–300 min of moderate intensity or 75–150 min of vigorous intensity, or an equivalent combination.[22] The Brazilian Ministry of Health adheres to worldwide WHO guidelines[5]. This study aimed to describe the pattern of leisure-time PA practice of adults with diabetic (18 years of age) living in the 26 Brazilian state capitals and the Federal District, served by at least one fixed telephone line, from the perspective that PA is a non-drug therapeutic component for people with diabetes and should be carried out systematically to maximize results. Second, to ensure that the PA, organized in accordance with the guidelines of the Brazilian Ministry of Health.

Aim

The purpose of this study was to describe the profile of PA of Brazilian adults with diabetes mellitus living in large Brazilian urban centers, as well as to determine whether the practice aligns with the PA guidelines recommended for people with diabetes.

Material and methods

The hypothesis pursued

This study was based on the hypothesis that Brazilian adults living with diabetes do not meet the minimum recommendations for physical activity recommended by the World Health Organization in order to achieve substantial health effects.

Study design

A descriptive study was conducted using secondary data collected by the Surveillance of Risk and Protective Factors for Chronic Non-communicable Diseases by Telephone Survey (VIGITEL) system, referring to a cross-sectional survey conducted in the capitals of Brazilian states and the Federal District, in 2020. A prior paper has the Vigitel methodology.[23]

In 2020, Vigitel set a minimum sample size of 1,000 persons for each city to estimate the frequency of the key risk factors for chronic non-communicable illnesses in the adult population (≥18 years) with a 95% confidence coefficient and a maximum error of two percentage points. Sex-specific estimates using sample weights that proportionality the difference between the sexes are projected to have maximum errors of three percentage points.[24]

A telephone interviewing organization conducted the interviews between February and December 2016. The interview crew consisted of 40 interviewers, two supervisors, and a coordinator; they had prior training and were overseen during the system's operation by the Center for Epidemiological Research in Nutrition and Health at the University of São Paulo. An electronic questionnaire used to collect information about the people's demographic, socioeconomic, and behavioral factors, as well as questions about the organization of leisure-time PA. Sex (female and male) and domicile by area (North, Northeast, Southeast, South, and Midwest) were the factors evaluated in the sample's sociodemographic makeup.

Sampling

Vigitel's sampling methodologies seek to acquire probabilistic samples of people (≥18 years old) residing in homes with at least one fixed telephone line in each capital of the 26 Brazilian states and the Federal District. Because of the limitations presented by the Covid-19 epidemic on data collecting in 2020, each city was required to have a minimum sample size of 1,000 people. With this sample, we can estimate the frequency of any risk or protective factor in the adult population with a 95% confidence level and a maximum error of three percentage points. Maximum errors of four percentage points are estimated for sex-specific estimates, assuming equal proportions of men and women in the sample.[24]

The initial stage of Vigitel's sample involves drawing at least 5,000 telephone lines in each city. This draw, which is systematic and stratified by postal address code, is made from the telephone providers' electronic registry of fixed home lines. The lines drawn in each city are then reshuffled and divided into 200 replicas, each with the same proportion of lines per ZIP code as the original register. In 2020, 183,600 phone lines were first drawn, with an average of 6,800 per city, divided into 34 replicates of 200 lines each. To meet the minimal number of about 1,000 interviews in each capital, an average of 32 replicas were deployed each city, ranging from 16 to 92 replicas.[24]

In the second step of Vigitel sampling, one adult (≥18 years old) from the home is drawn. This stage is completed after determining whether of the lines drawn are eligible for the system. Lines that relate to firms, no longer exist or are out of service, or do not reply to six phone attempts made on various days and hours, including Saturdays, Sundays, and nighttime periods, and are most likely associated with closed residences, are ineligible for the system. Vigitel called 183,600 phone lines dispersed in 876 replicates throughout all 26 state capitals and the Federal District in 2020, identifying 47,031 eligible lines.[24]

The following questions used to identify leisure-time PA practitioners: "In the last three months, have you practiced any type of physical exercise or sport?" With an affirmative response, the respondent moved on to the following question: "What is the main type of physical exercise or sport you have practiced?" The interviewer had to choose the first activity indicated by the responder from a list of 16 alternatives.

Weekly frequency of physical activity

The number of days per week that the respondent practiced PA determined the weekly frequency of PA. The data was gathered by asking, "How many days a week do you usually practice physical exercise or sport?" The responses divided into four categories: every day, 5 to 6 days, 3 to 4 days, and 1 to 2 days each week. The duration of each session's effort determined by the question: "On the day you exercise or do sport, how long does this activity last?" The responses divided into seven categories: less than 10, 10 to 19, 20 to 29, 30 to 39, 40 to 49, 50 to 59, and 60 minutes or more. Activities that take fewer than 10 minutes, weren't taken into account in the computation.[20]

The same criterion employed by VIGITEL in the 2020 edition, utilized to determine the intensity of the endeavor[25]. Walking, treadmill walking, aqua aerobics, general gymnastics, swimming, cycling, and volleyball, therefore classed as moderate-intensity physical activity routines. Vigorous-intensity PA included jogging, treadmill running, weight training, aerobics, martial arts/fighting, soccer, basketball, and tennis.

Classification of physical activity level

The participant PA levels were classified as sufficient or insufficient based on the target recommended by the Brazilian Ministry of Health for people with diabetes. Sufficient was defined as at least 150 minutes per week of aerobic or resistance exercise spread over three days per week and no more than two consecutive days.[5] Inactive during leisure time, allocated to the participant who did not engage in any leisure-time PA at least once per week for the three months preceding the survey. The notion active during leisure time was allocated to the participant who did some PA at least once a week for the three months preceding the survey.

We utilized the question "Has a doctor ever told you that you have diabetes?" to identify individuals having a previous medical diagnosis of DM.

Inference of estimates for the total adult population of each city

To extend the results to the population without a landline, post-stratification weights were used. Based on census data from the corresponding year, the "Rake" technique, used to estimate the total population of each capital. This method uses interactive procedures that take into account successive comparisons between estimates of the distribution of each sociodemographic variable in the Vigitel sample and in the city's total population. These comparisons result in the finding of weights which, when applied to

the Vigitel sample, equate its sociodemographic distribution to the distribution estimated for the city's total population. The distribution of each sociodemographic variable estimated for each city in 2020 was obtained from projections that took into account the distribution of the variable in the 2000 and 2010 Demographic Censuses and its average annual variation (geometric rate) in the intercensal period.[24]

Physical activity and its domains

Physical activity is understood as any movement produced by the skeletal muscles that requires energy expenditure greater than rest, covering various domains, such as leisure time activities, work and home activities and active commuting. Unlike physical exercise, PA does not necessarily require systematic execution.[26,31]

Leisure-time physical activity is recreational activity. The Vigitel survey offers a few options to choose from: walking, treadmill walking, weight training, aqua aerobics, gymnastics in general, swimming, martial arts and wrestling, cycling, volleyball/football, dancing, running, treadmill running, aerobics, football/futsal, basketball and tennis.

Physically active is equivalent to completing at least 150 minutes of moderate-intensity PA per week, or 75 minutes of vigorous-intensity physical activity per week, or any equivalent between them. PA lasting less than 10 minutes was not taken into account when calculating the weekly sum.

Physically inactive means not practicing any physical activity in their free time, not making any significant physical effort at work, not actively commuting (more than 10 minutes per commute or 20 minutes per day) and not taking part in heavy household chores.

Ethical aspects

Informed consent was obtained orally when the interviewees were contacted by telephone. The Vigitel project was approved by the Ministry of Health's National Research Ethics Committee for Human Beings (CAAE: 65610017.1.0000.0008). The literature review study that gave rise to this article is exempt from ethical analysis, as determined by Resolution 510/2016 – CNS, as it deals with publicly accessible secondary data, under the terms of Law No. 12,527, of November 18, 2017.[27]

Statistical analysis

The prevalence of PA among patients with diabetes, as well as their corresponding 95% confidence intervals, given by individual level of PA, region, and kind of PA. Pearson's chi-squared test, used to investigate potential changes in PA prevalence based on the presence or absence of DM. We employed a statistically significant difference, defined as a p-value less than 0.05. For data processing and statistical analysis, Stata® 11.0.

Results

One hundred twenty seven thousand telephones lines were initially allocated for the 2020 Vigitel study. Following pre-established criteria, 77,671 suitable lines were calculated, of which 53,210 responded to the interview, comprising 20,258 men and 32,952 women, showing a system success rate of 68.5% and an average interview time of around 11 minutes, ranging from 4 to 59 minutes. The proportion of people with a previous medical diagnosis of diabetes ranged from 5.3% in Boa Vista to 10.4% in Rio de Janeiro. Diabetes was more common in Rio de Janeiro (12%), São Paulo (11.1%), and Belo Horizonte (11%) among women, and less common in Palmas and Manaus (5.8%) and Teresina (6.5%) (data not presented in tables or figures).[24]

The study removed 1,535 participants (2.9%) who, although reporting practicing PA, did not provide information on the weekly frequency or duration of the activity. As a result, the calculation basis included 51,675 research participants.

People with DM were distributed unequally according to schooling, with 74.2% (95%CI: 71.6–76.8) having up to 8 years of schooling, 16.9% (95%CI: 14.5–18.7) having 9 to 11 years, and 8.9% (95%CI: 7.9–12.6) having more than 12 years (p=0.001). Diabetes was more frequent in older adults in both sexes, reaching roughly 1% of individuals aged 18 to 24 and 20% of participants aged 65 or older.

The categorization of the degree of PA of patients having a previous DM, is shown in Table 1. More over half of the patients (55%) were inactive in their spare time, and only 15% met the Ministry of Health's recommended PA threshold. Table 2 displays the percentage of participants who met the PA objective by area of residence. Women's PA levels were lower across the board, with the Northeast area outperforming the rest of the country. Reaching the goal was greater in the Midwest (18.2%; 95%CI: 14.4–20.8) and lower in the Northeast (14.2%; 95%CI: 12–15.4) among males. The Midwest area had the greatest PA goal accomplishment among women (15.5%; 95%CI: 13–18.1).

Table 1. Proportional distribution of people with diabetes, aged ≥ 18 years, according to PA level, by sex – Vigitel, Brazilian state capitals and Federal District, 2020*

	PA level of people with diabetes					
	Total		**men**		**women**	
	%	**95%CI**	**%**	**95%CI**	**%**	**95%CI**
Inactive + Ins. active	69.5	77.2–58.2	60.9	71.9–59.2	72.8	82.1–51.5
Active	45.5	43.3–51.6	54.1	49.2–58.3	42.2	39.4–45.1

* Percentage weighted to adjust the sociodemographic distribution of the Vigitel sample to the distribution of the adult population of each city projected for 2020

Table 2. Percentage of adults living with diabetes (≥ 18 years of age) who achieved the level of PA recommended by the WHO, by sex – Vigitel, Brazilian state capitals and the Federal District, 2020*

		PA sufficient	
Regions	**Prev**	**men**	**women**
		% 95%CI	% 95%CI
North	6.1%	14.5 (12.1–16.7)	12.3 (10.1–14.2)
Northeast	8.2%	14.2 (12–15.4)	12.1 (10.3–15.6)
Center-West	8%	18.2 (14.4–20.8)	15.5 (13–18.1)
Southeast	10.1%	16.3 (14.2–18.4)	13.8 (11.6–16.9)
South	8.3%	15.3 (13.5–17.9)	13.0 (10.9–15)

* Weighted percentage to adjust the sociodemographic distribution of the Vigitel sample to the distribution of the adult population of each city projected for 2020, 95% CI – 95% confidence interval, Prev – prevalence of diabetes

The primary PA reported by people with diabetes are shown in Table 3. Three out of every four people who completed the goal reported walking (74.2%; 95%CI: 68.4–80.5). Walking was reported less often by people with diabetes and lower levels of PA (54.6%; 95%CI: 45–66.1). Males were more likely to practice soccer than females.

Table 4, depicts the weekly frequency and length of PA sessions. PA frequency of 3 to 4 days per week, reported by 44.5% (95%CI: 42.8–46). Only 1.5% of the most active indicated a weekly frequency of one to two days. On active days, more than half of people with diabetes exercised for 60 minutes or more, and three-quarters exercised for 30 minutes or more every session. They exercised 1 to 2 days per week for 76.8% (95%CI: 61.6–91.9) of men and 81.6% (95%CI: 70–93.2) of women with DM who did not meet the objective.

Table 3. Percentage of people with diabetes, aged ≥ 18 years, according to the main type and level of PA reported, by sex – Vigitel, Brazilian state capitals and Federal District, 2020*

People living with diabetes	PA Sufficient						PA Insufficient					
Modalities	**Total %**	**(95%CI)**	**M %**	**(95%CI)**	**W %**	**(95%CI)**	**Total %**	**(95%CI)**	**M %**	**(95%CI)**	**W%**	**(95%CI)**
Walking	74.2	68.4–80.5	71.6	62.2–81	76.8	69.5–83.9	54.6	45.0–66.1	49.0	31.9–68.5	60	43.9–72.7
Treadmill walking	3.2	11.8–4.6	3.7	0.2–6.6	2.7	0.8–4.5	0.8	0.005–1.4	1.3	0.2–3	0.3	0.1–0.7
Jogging	1.3	0.4–2.6	1	0.1–2	1.6	0.05–40	2.5	0.4–5.8	2.4	0.8–5.3	2.8	0.2–7.7
Treadmill jogging	0.2	0.002–0.5	0.2	01–0.5	0.3	0.07–0.8	1.2	1.0–3.2	2.7	2.4–7.1	–	–
Bodybuilding	3.1	0.8–4.2	4.2	0.08–7.6	1.9	0.1–2.4	1.3	0.1–2.5	2.3	0.8–5.3	0.5	0.2–1.1
Aerobic gymnastics	1.4	0.01–2.5	2.1	0.6–4.8	0.7	0.004–1.2	0.9	0.4–1.8	1.3	1.3–3.8	0.2	0.06–0.5
Hydrogymnastics	5.1	1.9–8.4	2.2	0.9–5.1	7.9	2.3–12.4	9.1	1.7–16.3	3.5	0.1–6.5	13.1	15.8–25.9
General gymnastics	2.5	1.6–4.7	1.3	1.7–3.1	3.8	1.8–7.3	4.4	0.3–8.8	1.1	0.3–2.7	7.3	0.09–14.1
Swimming	0.7	0.05–1.8	0.9	0.5–2.1	0.6	0.4–1.2	0.9	0.004–1.6	1.2	0.6–2.8	0.5	0.05–1.3
Fights	0.1	0.01–0.1	0.5	0.2–1.3	–	–	0.4	0.3–1	0.8	0.8–2.4	–	–
Cycling	3.2	1.1–4.2	5.6	1.7–8.4	0.8	0.07–1.1	0.7	1.1–13.1	1.1	0.2–2.3	0.4	0.1–0.8
Football	2.7	0.08–3.1	4.8	1.6–6.9	–	–	9.1	4.9–13.2	21	10.7–31.2	–	–
Basketball	–	–	–	–	–	–	–	–	–	–	–	–
Volleyball	0.1	0.01–0.2	0.04	0.01–0.1	0.1	0.008–0.2	0.07	0.04–0.2	0.2	0.1–0.5	–	–

Tennis	–	–	–	–	–	–	0.01	0.08–0.3	0.2	0.2–0.7	–	–
Others	2.1	1.6–5.6	1.9	0.6–5.2	2.8	1.2–6.9	14	5.3–21.2	11	1.9–20.6	14.8	4.3–23.7

*Weighted percentage to adjust the sociodemographic distribution of the Vigitel sample to the distribution of the adult population of each city projected for 2020, 95%CI – 95% confidence interval

Table 4. Percentage distribution of people with diabetes (≥ 18 years of age), according to weekly frequency and daily duration of PA and level of PA (sufficient, insufficient) – Vigitel, Brazilian state capitals and Federal District, 2020*

	General population	People with diabetes
	% (95%CI)	% (95%CI)
PA SUFFICIENT		
Frequency (weekly)		
Every day	22.8 (21.3–24.3)	25.7 (17.9–5.0)
5–6	26.9 (25.4–28.3)	35.5 (26.4–44.5)#
3–4	44.5 (42.8–46)	37.4 (28.2–46.5)#
1–2	5.8 (0.5–6.6)	1.4 (0.7–3.7)#
Duration (minutes)		
<10	—	—
10–19	0.4 (0.1–0.6)	0.2 (0.1–0.5)
20–29	0.6 (0.1–0.9)	1.7 (0.8–2.6)#
30–39	5.1 (4.4–6.6)	6.3 (5.1–7.8)
40–49	10.9 (9.8–12.8)	13.6 (8,2–18.9)
50–59	13.5 (11.0–16.3)	17.5 (15.0–22.1)#
≥60	69.2 (68.5–71.4)	60.7 (52.7–68.3)#
PA INSUFFICIENT		
Frequency (weekly)		
Every day	2.4 (0.1–3.6)	3.9 (0.9–8.9)
5–6	1.7 (1.0–2.4)	4.4 (0.5–8.8)#
3–4	2.9 (2.2–3.6)	12 (4.8–19.2)#
1–2	93.0 (91.3–94.3)	79.7 (70.2–88.6)#
Duration (minutes)		
<10	0.6 (0.3–0.8)	0.6 (0.1–1.1)
10–19	3.4 (4.9–8)	4.6 (5.8–23.3)
20–29	4.2 (3.4–5)	5.6 (3.7–9.5)
30–39	4,1 (3.3–5.2)	9.9 (1.2–18.5)#
40–49	8.3 (6.9–9.7)	14 (12.4–16.3)#
50–59	11.8 (10.9–14.4)	14.5 (8.6–20.4)
≥60	67.6 (64.9–70.3)	50.8 (38.8–62.6)#

* Weighted percentage to adjust the sociodemographic distribution of the Vigitel sample to the distribution of the adult population of each city projected for 2020, 95%CI – confidence interval, # – statistically significant difference (Pearson chi-square test)

Discussion

The purpose of this study was to describe the structure of leisure-time PA for people with diabetes and to see if it met the guidelines of the Brazilian Ministry of Health. Walking, water aerobics, and gymnastics were the most common forms of PA reported, with women outnumbering males in all places questioned. The ultimate weekly amount of exercises resulted in 15% of people with diabetes meeting their PA goal.

The rise in the prevalence of DM complications has an impact on health-care management, raising the expense of disease prevention and treatment. Health surveillance strategies based on the development of improved living behaviors are critical to disease management. In this regard, and in accordance with WHO worldwide recommendations, the Brazilian Ministry of Health revised its strategy for diabetic self-care in 2013.

The most recent ones support the 2006 fundamental principles for practicing PA. Previously, the recommendations emphasized aerobic activity with a steady increase in length until attaining the aim of 30 to 60 minutes per day, 5 to 7 days per week. At least 150 minutes per week is now advised, with aerobic activities spaced out over three days per week and no more than two consecutive days, and resistance exercises (weight training) encompassing as many muscle groups as feasible. The suggestions do not mention whether the time spent on resistance exercises contributes to the aim.[5]

It is critical to discuss the weekly frequency and length of activities when establishing the weekly volume of PA. Although the daily length of activities is consistent with the requirements for 87% of active people with diabetes, the lower weekly frequency is a significant impediment to meeting the goal. In this regard, the major goal should be to increase the frequency of PA without affecting the duration of activities, which is recommended for most people with diabetes.

When you consider that PA-mediated insulin sensitization is peak 12 to 48 hours after the exercise session and gradually recovers to pre-activity levels, it is normally no more than 72 hours.[28] Training's effect on insulin sensitivity may remain a little longer, maybe because part of its benefits are mediated by muscle mass gain.[29] According to Thomas et al., the insufficient amount of effort may explain why many people with diabetes with insufficient PA have not improved their blood glucose control to the same level as adequately active people with diabetes.[30]

The most dangerous circumstance for people with diabetes' health was the complete lack of PA for the majority of people with diabetes (55%). Although different guidelines differ on the optimal way to obtain the minimum amount of PA to achieve significant health effects, all guidelines agree that the magnitude of the positive effect of PA on people with diabetes is greater when inactive people incorporate some degree of PA than when moderately active people increase their activity.[32-34] In this regard, beginning to practice some PA appears to be the most crucial step for the majority of people with diabetes.

Walking was chosen as the primary form of physical activity by nearly 74.2% of people with diabetes. This rate was greater than the general population (43%). Walking is a moderate-intensity aerobic activity, and it

was the exercise that contributed the most to meeting the PA goal.[25] This is in consistent with the Ministry of Health's recommendations, which favor volume over high intensity exercises.[5]

PA-mediated insulin sensitization occurs as a result of both aerobic and resistance exercise (weight training). The method by which various forms of exercise act appears to be distinct.[30] With this in mind, the Ministry of Health suggests mixing the two modes in a complimentary rather than alternative manner.[5] Resistance exercise (weight training) has been found to be safe for persons in their forties and fifties, including those at high risk of cardiac events.[22]

According to the findings of this survey, just 3% of the participants listed weight training as their primary activity. According to the opening remark in the preceding paragraph, not practicing weight training is contrary to MOH guidelines. However, as noted under the method's limitations, this information should be evaluated with caution due to the Vigitel survey's restriction of not defining types of activities carried out concurrently with the main activity. As a result, bodybuilding may be underrepresented in this study.

The emphasis on general care, focusing on individual criteria, stands out as a guiding concept. Knowledge of a prior DM diagnosis and the beneficial effects of PA on the illness might support the concept that people with diabetes should be or remain more physically active, hence protecting against disease progression and the formation of comorbidities. The decision to live a more active life is also influenced by the availability, opportunity, and safety of access to and permanency in public locations conducive to PA practice. As a result, it makes sense to integrate intersectional efforts to increase public health by promoting PA.

People with diabetes might benefit from better intersectional public planning. Measures to beautify the physical environment near residential areas, such as the creation of safe environments on sidewalks and at street crossings with reduced traffic speeds, the concentration of public access points for practicing PA away from places with heavy traffic and preventive policing, extending the opening hours of facilities for practicing PA and publicizing the existence of appropriate points for PA, may prove beneficial.

The study's strengths include data on leisure-time physical activity of a large sample of Brazilian adults living with diabetes residing in the capitals of the Brazilian states and the Federal District, which has been tracked on a regular basis by the Vigitel system since 2006. This study provides useful information on the organization of PA in order to strengthen activities aimed at encouraging people with diabetes to be more active, minimizing access disparities between sex and age groups, and guaranteeing appropriate and secure public venues for PA. The relevance of Primary Health Care services as an ideal location to provide advice on the benefits of PA, considering its closeness and penetration among patients with DM, cannot be overstated.

Study limitations

When evaluating the findings, some limitations of this study should be acknowledged. The Vigitel data was collected only through conversations with landline phone owners. The use of post-stratified weights

attempted to reduce any discrepancies between the entire population and the study population. However, residual selection bias may exist. The Vigitel survey's question on the kind of PA is not multiple choice, which makes it easy to underestimate some types of PA. Furthermore, the real amount of work cannot be proven. Direct measurements of PA might fulfill this constraint, but they are inappropriate for large-sample surveys like this one. Positive cases of illness knowledge were not validated on the spot. It should be recognized that some individuals interviewed may have been diabetic and were ignorant of their status. The utilization of a representative sample of the Brazilian population (around 30%) with solid validity and repeatability data is the study's strength.[29]

Conclusion

In 2020, 7.9% of the population identified themselves as having diabetes. There was a higher frequency among older women and those with less schooling. In the sample as a whole, approximately 70% of people living with diabetes were inactive (54.5%) or did not meet the minimum BP recommendations for people with diabetes. The duration of each session seemed to be in line with the recommendations, however, the lack of regularity caused by the low weekly frequency meant that the minimum recommended target could not be achieved. Efforts involving the continued monitoring of people living with diabetes and counseling in Primary Health Care to opt for a more physically active life, seem to be promising acts for a healthier life, pending a definitive resolution to the disease.

Declarations

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Author contributions

Conceptualization, D.F.L., A.A.S, D.C.S, D.M. and L.A.L.; Methodology, D.F.L., A.A.S, D.C.S, D.M. and L.A.L.; Software, D.F.L. and L.A.L; Validation, D.F.L., A.A.S, D.C.S, D.M. and L.A.L.; Formal Analysis, D.F.L. and L.A.L.; Investigation, D.F.L., A.A.S, D.C.S, D.M. and L.A.L.; Resources, D.F.L. and L.A.L; Data Curation, D.F.L., A.A.S, D.C.S, D.M. and L.A.L.; Writing – Original Draft Preparation, D.F.L.; Writing – Review & Editing, D.F.L., A.A.S, D.C.S, D.M. and L.A.L.; Visualization, D.F.L. and L.A.L.; Supervision, D.F.L., A.A.S, D.C.S, D.M. and L.A.L; Project Administration, D.F.L. and L.A.L.; Funding Acquisition, D.F.L. and L.A.L.

Conflicts of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Data availability

Data available on request from the authors.

Ethics approval

The Vigitel project was approved by the Ministry of Health's National Research Ethics Committee for Human Beings (CAAE: 65610017.1.0000.0008).

References

1. World Health Organization (WHO). 2006. *Technical report: Definition and diagnosis of people with diabetes mellitus and impaired glycaemic regulation*. Geneva; 2006.
2. American Diabetes Association (ADA). Diagnosis and classification of diabetes mellitus. *Diabetes Care*. 2010;33:62-69. doi: 10.2337/dc10-S062
3. Khan MAB, Hashim MJ, King JK, et al. Epidemiology of Type 2 Diabetes - Global Burden of Disease and Forecasted Trends. *J Epidemiol Glob Health*. 2020;10(1):107-111. doi: 10.2991/jegh.k.191028.001
4. Sun H, Saeedi P, Karuranga S, et al. People with diabetes Atlas: Global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. *Diabetes Res Clin Pract*. 2022;183:109119. doi: 10.1016/j.diabres.2021.109119
5. Muzy J, Campos MR, Emmerick I, Silva RS, Schramm JMA. Prevalence of diabetes mellitus and its complications and characterization of healthcare gaps based on triangulation of studies. *Cad. Saúde Pública.* 2021;37(5):e00076120. doi: 10.1590/0102-311x00076120
6. Kanaley JA, Colberg SR, Corcoran MH, et al. Exercise/Physical Activity in Individuals with Type 2 Diabetes: A Consensus Statement from the American College of Sports Medicine. *Med Sci Sports Exerc*. 2022;1;54(2):353-368. doi: 10.1249/MSS.0000000000002800
7. Stamatakis E, Straker L, Hamer M, Gebel K. The 2018 Physical Activity Guidelines for Americans: What's New? Implications for Clinicians and the Public. *J Orthop Sports Phys Ther*. 2019;49(7):487-490. doi: 10.2519/jospt.2019.0609
8. Jiang Y, Tan S, Wang Z, Guo Z, Li Q, Wang J. Aerobic exercise training at maximal fat oxidation intensity improves body composition, glycemic control, and physical capacity in older people with type 2 diabetes. *J Exerc Sci Fit*. 2020;18(1):7-13. doi: 10.1016/j.jesf.2019.08.003
9. Daryabor G, Atashzar MR, Kabelitz D, Meri S, Kalantar K. The Effects of Type 2 People Diabetes Mellitus on Organ Metabolism and the Immune System. *Front Immunol*. 2020;22(11):1582-96. doi: 10.3389/fimmu.2020.01582
10. Colosimo S, Tan GD, Petroni ML, Marchesini G, Tomlinson JW. Improved glycaemic control in patients with type 2 diabetes has a beneficial impact on NAFLD, independent of change in BMI or

glucose lowering agent. *Nutr Metab Cardiovasc Dis*. 2023;33(3):640-648. doi: 10.1016/j.numecd.2022.12.010

11. Sugimoto K, Ikegami H, Takata Y, et al. Glycemic Control and Insulin Improve Muscle Mass and Gait Speed in Type 2 diabetes: The MUSCLES-DM Study. *J Am Med Dir Assoc*. 2021;22(4):834-838.e1. doi: 10.1016/j.jamda.2020.11
12. Sacre JW, Harding JL, Shaw JE, Magliano DJ. Declining mortality in older people with type 2 diabetes masks rising excess risks at younger ages: a population-based study of all-cause and cause-specific mortality over 13 years. *Int J Epidemiol.* 2021;30;50(4):1362-1372. doi: 10.1093/ije/dyaa270
13. Zhang PY. Cardiovascular disease in diabetes. *Eur Rev Med Pharmacol Sci*. 2014;18(15):2205-2214 .
14. King CJ, Moreno J, Coleman SV, Williams JF. Diabetes mortality rates among African Americans: A descriptive analysis pre and post Medicaid expansion. *Prev Med Rep*. 2018;4(12):20-24. doi: 10.1016/j.pmedr.2018.08.001
15. Flores-Opazo M, McGee SL, Hargreaves M. Exercise and GLUT4. *Exerc Sport Sci Rev*. 2020;48(3):110-118. doi: 10.1249/JES.0000000000000224
16. Rezaeeshirazi R. Aerobic Versus Resistance Training: Leptin and Metabolic Parameters Improvement in Type 2 Diabetes Obese Men. *Res Q Exerc Sport*. 2022;93(3):537-547. doi: 10.1080/02701367.2021.1875111
17. Kanaley JA, Colberg SR, Corcoran MH, et al. Exercise/Physical Activity in Individuals with Type 2 Diabetes: A Consensus Statement from the American College of Sports Medicine. *Med Sci Sports Exerc*. 2022;54(2):353-368. doi: 10.1249/MSS.0000000000002800
18. Martin JC, Awoke MA, Misso ML, Moran LJ, Harrison CL. Preventing weight gain in adults: A systematic review and meta-analysis of randomized controlled trials. *Obes Rev*. 2021;22(10):e13280. doi: 10.1111/obr.13280
19. Collins KA, Ross LM, Slentz CA, Huffman KM, Kraus WE. Differential Effects of Amount, Intensity, and Mode of Exercise Training on Insulin Sensitivity and Glucose Homeostasis: A Narrative Review. *Sports Med Open*. 2022;14;8(1):90. doi: 10.1186/s40798-022-00480-5
20. World Health Organization (WHO). 2010. *WHO guidelines on physical activity and sedentary behaviour*. World Health Organization; Geneva, 2010.
21. Lima DF, Lima LA, Sampaio AA. Recreational physical activity in Brazilian older adults: secondary analysis of the 2018 Vigitel survey. *Geriatr Gerontol Aging.* 2022;16:e0220015. doi: 10.53886/gga.e0220015
22. Bull FC, Al-Ansari SS, Biddle S, Borodulin K, Buman MP, Cardon G, et al. Br *J Sports Med*. 2020;54:1451-1462. doi:10.1136/bjsports-2020-102955

23. Balko AB, Palavissini CFC, Souza DC, Lima LA, Lima DF. Nutritional ergogenic resources in sport: lights and shadows on their use. *Research, Society and Development*. 2022;11:1-8. doi: 10.33448/rsd-v11i1.25056
24. Lima DF, Lima LA, Sampaio AA. Recreational physical activity in Brazilian older adults: secondary analysis of the 2018 Vigitel survey. *Geriatr Gerontol Aging.* 2022;16:e0220015. doi: 10.53886/gga.e0220015
25. Ainsworth BE, Haskell MC, Whitt ML, et al. Compendium of physical activities: um update of activity codes and MET intensities. *Med Sci Sports Exerc*. 2000;32:498-516. doi: 10.1097/00005768-200009001-00009
26. Stachelski RA, Torrilhas B, Camboin FF, et al. Therapeutic Exercise in Plantar Fasciitis: A Systematic Review with Meta-Analysis. *Muscles, Ligaments and Tendons Journal*. 2024;14(1):29-45. doi: 10.32098/mltj.03.2024.04
27. Lima DF, Ferreto LED, Buzanello MR. Consent for processing medical records data. *Rev bioét*. 2023;31:e3589EN. doi: 10.1590/1983-803420233589EN
28. Assumpção D, Ruiz AMP, Borim FSA, et al. Eating Behavior of Older Adults with and Without Diabetes: The Vigitel Survey, Brazil, 2016. *Arq Bras Cardiol*. 2022;118(2):388-397. doi: 10.36660/abc.20201204
29. U.S. Department of Health and Human Services- USDHHS. 1997; *Guidelines for school and community programs to promote lifestyle physical activity among young people*. Centers for Disease Control and Prevention (CDC) Atlanta, Georgia, 1997;46:1-36.
30. Lima DF, Piovani VGS, Lima LA. Recreational soccer practice among adults, in Brazilian capitals, 2011-2015. *Epidemiol Serv Saude*. 2018;27(2):e2017284. doi: 10.5123/S1679-49742018000200013