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**Original Article**

# TIME TRENDS OF RESISTANCE TRAINING PRACTICE IN BRAZILIAN ADULTS FROM 2006 TO 2018: AN ECOLOGICAL TIME-SERIES STUDY

## TENDÊNCIAS TEMPORAIS DA PRÁTICA DE TREINAMENTO RESISTIDO DE 2006 A 2018: UM ESTUDO ECOLÓGICO DE SÉRIES TEMPORAIS

**Suéli Guarnieri[1], Murilo Bastos[1], Ana Carolina Paludo[2], Angelica Miki Stein[1,3], Danilo Fernandes da Silva[4], Italo Witeck[1],** and **Michael Pereira da Silva[5]**

[1]Midwestern State University, Guarapuava-PR, Brazil.
[2] Masaryk University, Brno, Czech Republic.
[3]Technological Federal University of Paraná, Curitiba, Brazil.
[4]University of Ottawa, Ottawa-ON, Canada.
[5] Federal University of Rio Grande, Rio Grande-RS, Brazil.

**RESUMO**

O exercício físico regular é obrigatório para a saúde, independentemente da modalidade. No entanto, recomenda-se incluir exercícios de força além dos exercícios aeróbicos. O objetivo do estudo foi verificar as tendências temporais da prática do treinamento resistido em uma amostra representativa de adultos brasileiros de 2006 a 2018. O estudo ecológico de série temporal utilizou os dados secundários obtidos do Sistema de Vigilância de Fatores de Risco para Doenças Crônicas Não Transmissíveis (VIGITEL) do Ministério da Saúde do Brasil. A pesquisa resultou em uma amostra representativa de 677.819 adultos brasileiros de 18 a 120 anos de idade. A prática de treinamento de resistência foi autorrelatada. As análises foram realizadas na amostra geral e por grupos etários. Regressões de Prais-Winsten foram usadas para analisar as tendências temporais, e o nível de significância foi definido como $p < 0,05$. Na amostra geral, houve uma taxa de crescimento anual (AGR) de 0,47% (intervalo de confiança de 95% (IC95%) = 0,03; 0,90, p = 0,03) na prática de treinamento de resistência. Em relação às faixas etárias, constatamos um aumento significativo na prática do treinamento de resistência ao longo do tempo nas faixas etárias de 35 a 54 anos (AGR = 0,65%; IC 95% = 0,44; 0,86, p = 0,001), 55 a 64 anos (AGR = 0,41, IC 95% = 0,23; 0,58, p = 0,001) e ≥ 65 anos (AGR = 0,22, IC 95% = 0,07; 0,37, p = 0,007). Com base nos resultados, a prática de treinamento resistido aumentou entre os brasileiros de 2006 a 2018, principalmente entre aqueles com mais de 35 anos de idade.
**Palavras-chave**: Adultos; Saudáveis; Epidemiologia; Exercícios Físico; Treinamento resistido.

**ABSTRACT**

Regular physical exercise is mandatory for health, regardless of the modality. However, it is recommended to include resistance exercises in addition to aerobic exercises. The study aimed to verify the time trends of the resistance training practice in a representative sample of Brazilian adults from 2006 to 2018. The ecological time-series study used the secondary data obtained from the Risk Factors Surveillance System for Chronic Non-communicable Diseases (VIGITEL) of the Brazilian Ministry of Health. The search resulted in a representative sample of 677,819 Brazilian adults from 18 to 120 years old. The resistance training practice was self-reported. Analyses were performed in the overall sample as well as by age groups. Prais-Winsten regressions were used to analyze the time trends, and the significance level was set at $p < 0.05$. In the overall sample, there was an annual growth rate (AGR) of 0.47% (95% confidence interval (95%CI) = 0.03; 0.90, p= 0.03) in resistance training practice. For the age groups, we found a significant increase in resistance training practice over time in those aged 35-54 years (AGR = 0.65%; 95% CI = 0.44; 0.86, p= 0.001), 55-64 years (AGR = 0.41, 95% CI = 0.23; 0.58, p=0.001) and ≥ 65 years (AGR = 0.22, 95% CI = 0.07; 0.37, p = 0.007). Based on the results, the resistance training practice increased among Brazilians from 2006 to 2018, particularly among those over 35 years old.
**Keywords**: Adults. Healthy; Epidemiology; Physical exercise; Resistance training.

## Introduction

The benefits of physical activity in adults are indisputable and well documented in the literature[1], being part of health guidelines and public policies worldwide[2]. The guidelines recommend that adults and older adults engage in aerobic physical activity and resistance exercises involving the whole body at least twice a week[2]. The American College of Sports Medicine (ACSM) was one of the first organizational institutions that provided guidelines and programs highlighting the importance of the resistance training in adults[3]. Resistance training

consists of performing external resistance in a specific muscle or group to improve strength, power, hypertrophy, and motor performance[3]. It has been associated with reduced all-cause mortality and incidence of cardiovascular and improved muscle strength and physical function in healthy adults[4].

Time trend analyses on physical activity can reflect the country's situation in stimulating exercise practice through the years. In Brazil, a time trend study demonstrated that strength training was the second activity most performed by Brazilians until 2012, with a slight and processive increase from 7.9 to 11.2% between 2006 to 2012, respectively[5]. Considering the recommendations for resistance training practice, it can observe that still a low percentage of the population is engaged in this exercise modality. However, similar outcomes were found in Australian adults, presenting increased adherence to physical activities focused on muscle strengthening from 6.4% to 12.0% between 2001 and 2010[6]. In 2018, before the COVID-19 pandemic, Brazil had approximately 208,5 million people, of which 69.4% had between 15-64 years old (IBGE), an estimated 34,509 gyms, with approximately 9.6 million clients[7]. Thus, an increase in resistance training practice in the adult population was expected since the last time trend analysis study[5].

To the best of our knowledge, there is no up-to-date study evaluating the time trends of the resistance training practice in a nationwide representative sample of Brazilian adults. Given all the potential health-related benefits of resistance training for the adult population, the description of these time trends is helpful information for researchers, epidemiologists, exercise professionals, and policymakers to discuss strategies to maintain or increase these rates in the population and determine long-term goals. Moreover, it serves as a point of comparison between Brazilians and other nations. This study used secondary data from the Brazilian Risk Factors Surveillance System for Chronic Non-communicable Diseases (VIGITEL)[8] to verify the time trends in the resistance training practice in a representative sample of Brazilian adults from 2006 to 2018. Since the VIGITEL survey indicates resistance training as a practice of strength training occurring in gyms or similar places. We hypothesized that resistance training practice increased in Brazilian adults from 2006 to 2018, irrespective of biological sex and age.

## Methods

*Sample*

The participants were examined based on cross-sectional data from the surveillance system called VIGITEL. The system aimed to describe the risk and protective factors for non-transmissible chronic diseases in the Brazilian population by telephone interview. In 2006, the VIGITEL system started to annually interview (via telephone) about 54,000 adults aged 18 years or older living in a household with at least one landline telephone in the 26 Brazilian State capitals and the Federal District[8].

The system establishes a minimum sample size of approximately two thousand individuals for each city to estimate the frequency of specific risk factors for non-communicable diseases in Brazilian adults with a 95% confidence interval and an error of 2%[8]. From 2006 to 2018, VIGITEL conducted 677,819 interviews with female and male Brazilian adults. The VIGITEL uses the rake method to calculate post-stratification sample weights to adjust the sample distribution according to the sociodemographic information for each city. All participants were provided an informed consent orally at the beginning of the telephone interviews. The VIGITEL project was approved by the Research Ethics Commission involving Human Participants from the Brazilian Ministry of Health (protocol: 4324071, CAAE: 65610017.1.0000.0008), and the present study followed ethical policies related to scientific discoveries in exercise science as described elsewhere[8].

*Procedures*

It is a time-series study using cross-sectional data from the VIGITEL survey of the Brazilian Ministry of Health. Initially, we used data from 342,389 adults who reported regularly practicing some type of physical exercise. This information was assessed through the question, "In the past three months, did you practice any type of physical exercise or sport?". Then the prevalence of resistance training practice was assessed through an additional question: "What is the main type of physical exercise or sport that you practiced?" which provided a series of exercise and sports options, including "resistance training". The VIGITEL questionnaire has adequate validity (area under the curve, AUC = 0.75) and reliability (Kappa = 0.70) to assess aspects of physical activity in Brazilian adults[9]. The year of data collection was collected from the VIGITEL database to be used in our analysis. The resistance training prevalence were stratified by factors such as biological sex (i.e., males and females) and age categories (e.g., 18-34; 35-54; 55-64; and ≥ 65 years), creating a sub-group analysis of time trends.

*Statistical analysis*

Absolute and relative frequency were used to describe physical exercise or sports prevalence and the prevalence of resistance training practice. Prais-Winsten regression models analyzed the time trends of resistance training practice in adults for the overall sample, each sex, and each age group. Sample weights adjusted the prevalence estimates of resistance training practice. It used these prevalence rates as dependent variables and the years of data collection as the independent variable. The regression coefficients represented the prevalence annual growth rate (AGR) in % with a 95% confidence interval (95%CI). We assumed significant changes when regression coefficients differed significantly from zero ($p<0.05$). The software STATA MP 14.1 (StataCorp LLC, College Station, Texas, United States) was used to perform all the analyses. We further calculate a posteriori sample power using the G*Power 3.1 calculator. The number of observations (e.g. 12-time points) was sufficient to identify regression coefficients ≥ 0.22 with a power of 0.74.

## Results

*Prevalence of Physical Activity and Resistance Training in Brazilian Adults*

The sociodemographic characteristics of the participants are displayed in Table 1. Considering the sub-groups of sexes and age, it is possible to notice that from 2006 to 2018, most participants were females (55.59%), and the group ages ranged between 18 to 34 years old (55.62%). Table 2 outlines the prevalence of physical exercise practice in Brazilian adults from 2006 to 2018. Overall, we found that 50.51% of the participants indicated practicing some type of physical exercise. Analyzing the prevalence throughout the years, we can see that 2012 was the first time in which the percentage of adults practicing physical exercise was slightly higher than non-practitioners. Among the exercise practitioners, 14.19% (7.16% of the overall sample) indicated practicing resistance training.

Table 1 - Demographic characteristics of resistance training practitioners - Risk Factors Surveillance System for Chronic Non-communicable Diseases (VIGITEL), Brazil.

| | 2006 n (%) | 2007 n (%) | 2008 n (%) | 2009 n (%) | 2010 n (%) | 2011 n (%) | 2012 n (%) | 2013 n (%) | 2014 n (%) | 2015 n (%) | 2016 n (%) | 2017 n (%) | 2018 n (%) | Overall n (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sex** | | | | | | | | | | | | | | |
| Men | 1519 (49.92) | 1669 (48.69) | 1532 (48.31) | 1647 (47.55) | 1577 (44.60) | 1628 (47.05) | 1513 (44.46) | 1902 (44.78) | 1402 (42.63) | 1962 (42.71) | 1793 (42.48) | 1663 (40.34) | 1761 (38.36) | 21568 (44.41) |
| Women | 1524 (50.08) | 1759 (51.31) | 1639 (51.69) | 1817 (52.45) | 1959 (55.40) | 1832 (52.95) | 1890 (55.54) | 2345 (55.22) | 1887 (57.37) | 2632 (57.29) | 2428 (57.52) | 2459 (59.66) | 2830 (61.64) | 27001 (55.59) |
| **Age groups** | | | | | | | | | | | | | | |
| 18 to 34 years | 2044 (67.17) | 2227 (64.96) | 2008 (63.32) | 2128 (61.43) | 2126 (60.12) | 2116 (61.16) | 1948 (57.24) | 2418 (56.93) | 1798 (54.67) | 2282 (49.67) | 2131 (50.49) | 1870 (45.37) | 1920 (41.82) | 27016 (55.62) |
| 35 to 54 years | 831 (27.31) | 972 (28.35) | 911 (38.73) | 991 (28.61) | 1073 (30.35) | 987 (28.53) | 1055 (31.00) | 1252 (29.48) | 1035 (31.47) | 1520 (33.09) | 1328 (31.46) | 1396 (33.87) | 1652 (35.98) | 15003 (30.89) |
| 55 to 64 years | 114 (3.75) | 152 (4.43) | 162 (5.11) | 226 (6.52) | 213 (6.02) | 224 (6.47) | 226 (6.64) | 351 (8.26) | 267 (8.12) | 438 (9.53) | 410 (9.71) | 451 (10.94) | 565 (12.31 | 3799 (7.82) |
| ≥65 years | 54 (1.77) | 77 (2.25) | 90 (2.84) | 119 (3.44) | 124 (3.44) | 133 (3.84) | 174 (5.11) | 226 (5.32) | 189 (5.75) | 354 (7.77) | 352 (8.35) | 405 (9.83) | 454 (9.89) | 2751 (5.66) |

**Source:** authors

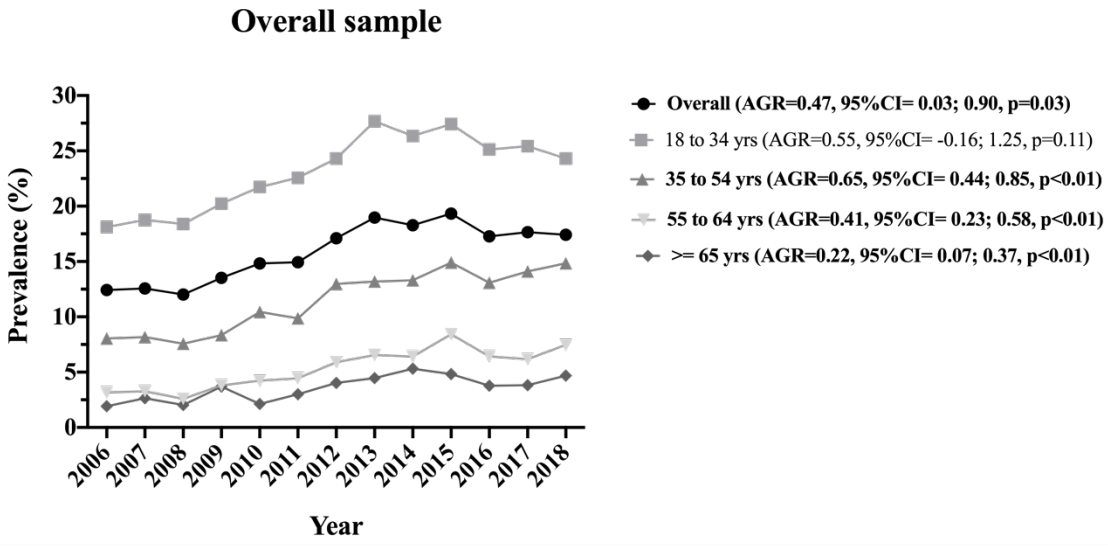
**Table 2** -Prevalence of physical exercise and resistance training practice for each year of Risk Factors Surveillance System for Chronic Non-communicable Diseases (VIGITEL) data collection - from 2006 to 2018, Brazil (n = 677,819).

| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Physical Exercise** | **N** | **N** | **n** | **n** | **n** | **n** | **n** | **n** | **n** | **n** | **n** | **n** | **n** | **n** |
| | **(%)** | **(%)** | **(%)** | **(%)** | **(%)** | **(%)** | **(%)** | **(%)** | **(%)** | **(%)** | **(%)** | **(%)** | **(%)** | **(%)** |
| Yes | 24898 | 27014 | 25283 | 25576 | 25519 | 26406 | 22778 | 26591 | 20877 | 28938 | 29098 | 29323 | 30088 | 342389 |
| | (47.16) | (48.39) | (46.52) | (47.04) | (46.96) | (48.77) | (50.12) | (50.24) | (51.10) | (53.42) | (54.69) | (55.29) | (57.43) | (50.51) |
| No | 27898 | 28810 | 29070 | 28791 | 28820 | 27738 | 22670 | 26338 | 19976 | 25236 | 24112 | 23711 | 22307 | 335499 |
| | (52.84) | (51.61) | (53.48) | (52.96) | (53.04) | (51.23) | (49.88) | (49.76) | (48.90) | (46.58) | (45.31) | (44.71) | (42.57) | (49.49) |
| **Resistance Training** | | | | | | | | | | | | | | |
| Yes | 3043 | 3428 | 3171 | 3464 | 3536 | 3460 | 3403 | 4247 | 3289 | 4594 | 4221 | 4122 | 4591 | 48569 |
| | (12.22) | (12.69) | (12.54) | (13.54) | (13.86) | (13.10) | (14.94) | (15.97) | (15.75) | (15.88) | (14.51) | (14.06) | (15.26) | (14.19) |
| No | 21855 | 23586 | 22112 | 22112 | 21983 | 22946 | 19375 | 22284 | 17588 | 24344 | 24877 | 25201 | 25497 | 293820 |
| | (87.78) | (87.31) | (87.46) | (86.46) | (86.14) | (86.90) | (85.06) | (84.03) | (84.25) | (84.12) | (85.49) | (85.94) | (84.74) | (85.81) |

**Source:** authors.

## Time Trend of Resistance Training in Brazilian Adults: Sexes and age categories

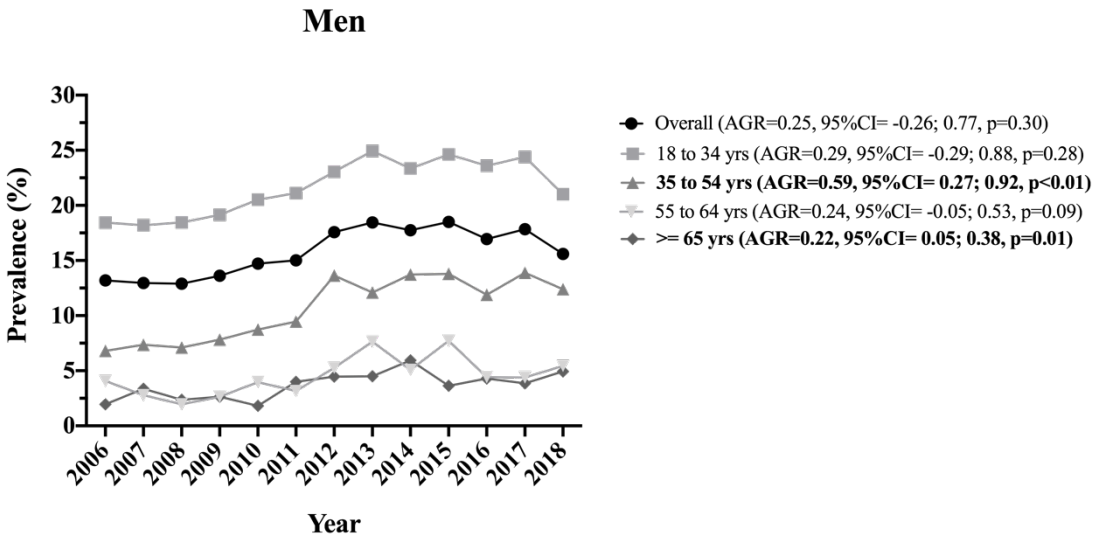
The outcome of the overall sample for time trends of resistance training practice in Brazilian adults from 2006 to 2018 is presented in Figure 1. The resistance training practice for the overall sample increased from 2006 (12.43%) to 2018 (17.42%), with an AGR of 0.47 % (95% CI = 0.03; 0.90, p = 0.03). Resistance training practice increased for specific age groups with AGR ranging from 0.22 % (95% CI = 0.07; 0.37, p= 0.007) for participants aged ≥ 65 years old to 0.65% (95% CI = 0.44; 0.86, p = 0.001) for participants with 35 to 54 years old.




| | Prevalence (%)* | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** |
| **Overall** | 12.43 | 12.57 | 12.02 | 13.53 | 14.83 | 14.93 | 17.10 | 18.97 | 18.28 | 19.34 | 17.28 | 17.65 | 17.42 |
| **Age groups** | | | | | | | | | | | | | |
| 18 to 34 yrs | 18.12 | 18.75 | 18.39 | 20.22 | 21.74 | 22.56 | 24.31 | 27.67 | 26.35 | 27.41 | 25.13 | 25.43 | 24.31 |
| 35 to 54 yrs | 8.04 | 8.17 | 7.57 | 8.34 | 10.45 | 9.87 | 12.98 | 13.19 | 13.31 | 14.91 | 13.08 | 14.10 | 14.84 |
| 55 to 64 yrs | 3.18 | 3.27 | 2.59 | 3.80 | 4.23 | 4.45 | 5.90 | 6.56 | 6.41 | 8.42 | 6.43 | 6.17 | 7.46 |
| ≥ 65 yrs | 1.92 | 2.64 | 2.04 | 3.70 | 2.12 | 3.00 | 4.03 | 4.47 | 5.31 | 4.82 | 3.77 | 3.83 | 4.68 |

**Figure 1 -** Time trends in resistance training practice in the overall Brazilian adults from 2006 to 2018 - Risk Factors Surveillance System for Chronic Non-communicable Diseases (Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico, VIGITEL), Brazil.
**Note**: *Prevalence corrected with sample weights. AGR = annual growth rate. CI = confidence interval.
**Source:** authors.

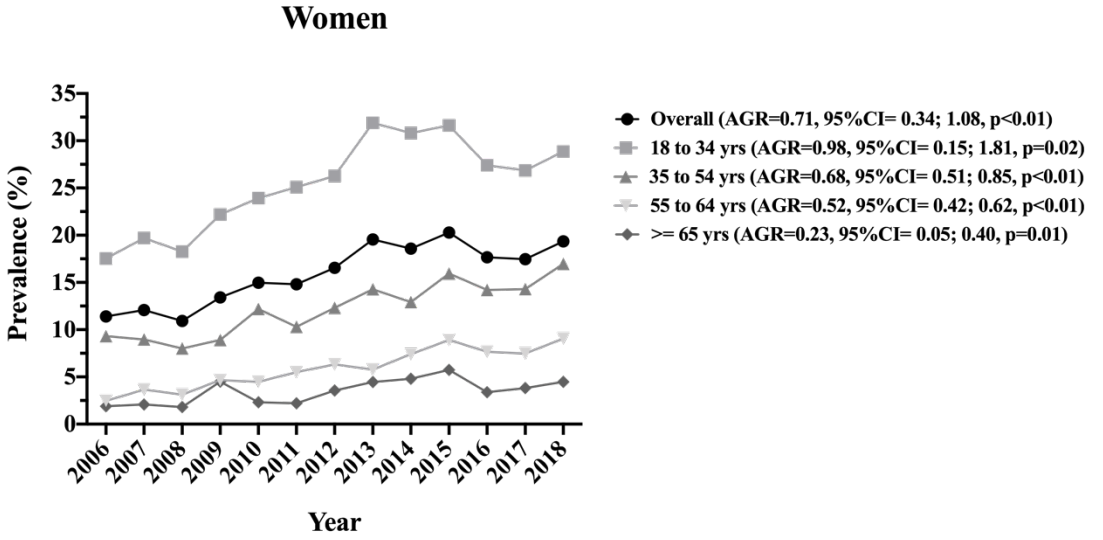
Figure 2 presents the outcome of male time trends of resistance training practice in Brazilian adults from 2006 to 2018. Resistance training practice increased in males aged 35 to 54 with an AGR of 0.59 % (95% CI = 0.27; 0.97, p= 0.002). Males aged ≥ 65 also presented higher resistance training practice rates with an AGR of 0.22 % (95% CI = 0.05; 0.38, p = 0.013).




| | Prevalence (%)* | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** |
| **Overall** | 13.20 | 12.96 | 12.90 | 13.62 | 14.71 | 15.02 | 17.57 | 18.46 | 17.75 | 18.50 | 16.95 | 17.84 | 15.60 |
| **Age groups** | | | | | | | | | | | | | |
| 18 to 34 yrs | 18.44 | 18.20 | 18.46 | 19.15 | 20.52 | 21.10 | 23.06 | 24.94 | 23.35 | 24.63 | 23.61 | 24.39 | 21.01 |
| 35 to 54 yrs | 6.81 | 7.36 | 7.11 | 7.82 | 8.74 | 9.46 | 13.63 | 12.10 | 13.73 | 13.79 | 11.89 | 13.89 | 12.40 |
| 55 to 64 yrs | 4.08 | 2.79 | 1.95 | 2.64 | 3.96 | 3.17 | 5.26 | 7.63 | 5.08 | 7.71 | 4.42 | 4.39 | 5.44 |
| ≥ 65 yrs | 1.96 | 3.36 | 2.37 | 2.65 | 1.82 | 4.00 | 4.46 | 4.50 | 5.94 | 3.63 | 4.29 | 3.85 | 4.93 |

**Figure 2 -** Time trends in resistance training practice in Brazilian males from 2006 to 2018 - Risk Factors Surveillance System for Chronic Non-communicable Diseases (Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico, VIGITEL), Brazil. *Prevalence corrected with sample weights. AGR = annual growth rate. CI = confidence interval.
**Source**: authors.

The outcome of female time trends of resistance training practice in Brazilian adults from 2006 to 2018 is presented in Figure 3. Resistance training practice increased in females for both the overall sample (AGR = 0.71 %, 95% CI = 0.34; 1.08, p= 0.002), and for each age group, with AGR ranging from 0.23 % (95% CI = 0.05; 0.40, p = 0.01) for females aged ≥ 65 years old) to 0.98 % (95% CI = 0.15; 1.81, p = 0.02) for women aged 18 to 34 years old.




| | Prevalence (%)* | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| **Overall** | 11.41 | 12.08 | 10.92 | 13.41 | 14.98 | 14.81 | 16.55 | 19.56 | 18.58 | 20.29 | 17.66 | 17.46 | 19.35 |
| **Age groups** | | | | | | | | | | | | | |
| 18 to 34 yrs | 17.54 | 19.69 | 18.27 | 22.18 | 23.93 | 25.08 | 26.27 | 31.90 | 30.81 | 31.63 | 27.40 | 26.86 | 28.86 |
| 35 to 54 yrs | 9.31 | 8.97 | 8.01 | 8.91 | 12.19 | 10.31 | 12.31 | 14.27 | 12.92 | 15.95 | 14.21 | 14.29 | 16.97 |
| 55 to 64 yrs | 2.46 | 3.66 | 3.13 | 4.67 | 4.47 | 5.51 | 6.33 | 5.78 | 7.40 | 8.91 | 7.67 | 7.48 | 9.06 |
| ≥ 65 yrs | 1.89 | 2.08 | 1.80 | 4.50 | 2.32 | 2.21 | 3.57 | 4.46 | 4.80 | 5.74 | 3.38 | 3.81 | 4.48 |

**Figure 3 -** Time trends in resistance training practice in the overall Brazilian females from 2006 to 2018 - Risk Factors Surveillance System for Chronic Non-communicable Diseases (Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico, VIGITEL), Brazil. *Prevalence corrected with sample weights. AGR = annual growth rate. CI = confidence interval.
**Source**: authors

## Discussion

The main aim of this study was to verify the time trends of resistance training practice in a representative sample of Brazilian adults from 2006 to 2018. It was hypothesized that resistance training practice would increase over the years. As a main result, higher annual growth rates of resistance training practice were found in the overall sample, in males aged 35 to 54 and ≥ 65 years old and women of all ages.

The World Health Organization [2] recommends that adults between 18- and 64-years old practice at least 150 minutes of moderate or 75 minutes of vigorous physical activity per week to achieve health benefits. It includes muscle and bone strengthening exercises at least twice a week[10]. This recommendation is supported by the several health benefits of resistance training, such as a better quality of life[11], cardiometabolic health[11,12], reduced risk of some types of cancer[13], lower risk of falling in older people[14], and attenuation of the aging effects on the muscle tissue function and structure[15,16]. Few studies have evaluated the time trends of resistance training practice in representative samples. Recent evidence shows a significant increase in this type of physical exercise in adults. A 10-year monitoring study with Australian adults found increased resistance training practice, with rates ranging from 6.4% to 12.0%[17]. During the seven-year monitoring period, a study with American adults found a small but significant increase of 1.2% in resistance training practice[18].

Previous studies using VIGITEL data also indicated an increase in resistance training practice from 2006 to 2012 (0.50 % and year - nationwide sample)[19] and 2006 to 2014 (4.0% and year - southern city sample)[20]. However, the only previous time-series study using a

nationwide sample of Brazilian adults[19] was grouped into the same category of participants who indicated practicing resistance training and practitioners of other exercises such as gym aerobics, stretching, pilates, and yoga. Global data from 1.9 million participants indicates that females are less physically active than their male counterparts[21]. In the present study, the increase of the resistance training practice in females was identified for all ages and suggests that resistance training might be a good option for females to engage in regular physical activity.

The trends of increase in resistance training reported in all age groups for the female population is promising, given that resistance exercise can reduce the risk of breast, colon, and endometrial cancers[13], prevent sarcopenia and Dinapenia[22], and might be an alternative to manage osteoporosis[23]. Females have lower muscle mass than males and are more predisposed to decrease muscle mass and strength due to aging[22,24]. The increase in resistance training practice is promising since involvement in these activities can promote higher muscle mass gains in early adulthood and muscular maintenance throughout the aging process[22]. On the other hand, according to a survey by the Brazilian Institute of Geography and Statistics in 2018, more than half of females are involved with physically demanding jobs (e.g., housemakers, caregivers)[25], possibly affecting their availability to practice physical exercise. At the same time, the main reason for females to engage in physical exercise seems to be related to reaching a beauty pattern[26] and minimizing body dissatisfaction[27] more often observed in women than men.

Another important finding of the present study was the increase in the practice of resistance training in older people (aged ≥ 65 years old), regardless of their biological sex, with annual growth rates of approximately 0.23%. The practice of this type of physical exercise is essential for this age group as they are more prone to present muscle weakness, involuntary weight loss, worse gait capacity, low physical capacity, and declined physical activity levels[14]. Additionally, resistance training helps improve muscle mass, cardiovascular system, balance, cognitive function, and gait, reducing the risk of falls in older people[14,22,28]. We assume that the growth in resistance training practice might be influenced by the increase in the number of gyms in the country since the country ranks second in the world's ranking of the number of gyms[29]. However, this assumption requires further investigation.

This study is the first to show time trends of the resistance training practice in a representative sample of adults living in all 26 Brazilian state capitals and the Federal District from 2006-2018; however, it is not free of limitations. VIGITEL limited interviews with fixed telephone lines. The fixed telephone line is generally associated with sectors of the population with higher education and income. Although this procedure can lead to selection bias, sample weights aim to reduce these problems and guarantee the sample's representativeness. Memory and social desire bias can affect the self-report measure of physical exercise and resistance training used in this study. However, self-reported measures are common in national surveys, and the VIGITEL questionnaire has adequate validity and reliability to assess physical (in)activity in Brazilian adults[9].

## Conclusion

The practice of resistance training increased for the overall sample and adults over the age of 35 years. Males of 35 to 54 and ≥ 65 years old and females of all ages increased their resistance training practice from 2006 to 2018. However, despite the positive aspect of the findings, it remains to be explored the adherence of individuals to this type of physical exercise since the results found in this study are an excerpt of the number of people practicing each year, but it does not demonstrate how long they have been practicing. Therefore, we suggest studies investigating adherence to resistance exercise. In addition, the prevalence of resistance exercise

is still low, so studies investigating strategies that can increase the population's participation in this type of exercise can increase annual growth rates and add even more health benefits.

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**ORCID**:
Suéli Guarnieri: https://orcid.org/0000-0002-9599-8576
Murilo Bastos: https://orcid.org/0000-0003-0358-8738
Ana Carolina Paludo: https://orcid.org/0000-0001-8771-4580
Angelica Miki Stein: https://orcid.org/0000-0002-2404-808X
Danilo Fernandes da Silva: http://orcid.org/0000-0002-4170-1079
Italo Witeck: https://orcid.org/0000-0002-5350-3459
Michael Pereira da Silva: https://orcid.org/0000-0002-7628-3997

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**Corresponding author:** Michael Pereira da Silva. E-mail: mpsilva@furg.br