# Multimorbidity in older adults and its associated factors in 2010 and 2021

Emanuelly Casal Bortoluzzi[1]
Andreia Mascarelo[2]
Marilene Rodrigues Portella[2]
Shana Ginar da Silva[3]
Ana Luisa Sant'Anna Alves[2]

## Abstract

The present study aimed to compare the factors associated with multimorbidity in older adults aged 60 to 69 years, in 2010 and 2021. This is a comparative cross-sectional study, comprised of other two cross-sectional studies. Both data collections were individually conducted by trained interviewers through household surveys in the municipality of Coxilha-RS, Brazil. Bivariate inferential analysis was conducted using Fisher's exact test and chi-square test, while multivariate analysis employed Poisson regression with robust variance with a significance level of $p<0.05$. It was observed that the prevalence of multimorbidity significantly decreased, decreasing from 66.5% in 2010 to 41.6% in 2021. Dependency for basic and instrumental activities of daily living was associated with higher prevalence of multimorbidity in the year 2010. However, in 2021, being dependent on instrumental activities, being unable to read/write, and being unemployed showed higher prevalence for multimorbidity. In conclusion, it is evident that the health conditions of older adults differed significantly over the years, highlighting the necessity for a reevaluation of healthcare practices to become more effective.

**Keywords**: Multimorbidity. Older adults. Daily Activities.

[1] Instituto de Desenvolvimento Educacional de Passo Fundo. Passo Fundo, RS, Brasil.

[2] Universidade de Passo Fundo, Programa de Pós-Graduação em Envelhecimento Humano (PPGEH). Passo Fundo, RS, Brasil.

[3] Universidade Federal da Fronteira Sul, Faculdade de Medicina (CCM-PF). Passo Fundo, RS, Brasil.

Funding: There was no funding for the execution of this work.

The authors declare that there is no conflict in the conception of this work.

Correspondence
Emanuelly Casal Bortoluzzi
manu.casalbortoluzzi@gmail.com

**Received: October 09, 2023**
**Approved: February 29, 2024**

http://dx.doi.org/10.1590/1981-22562024027.230231en

## INTRODUCTION

In older population, the high prevalence of chronic diseases is a reality, each of which requires specific treatment. However, the presence of multimorbidity, often defined as the coexistence of two or more chronic physical or mental health conditions[1,2], and the challenges posed by this condition, have become a global issue.Considering the evidence of the negative impacts of multimorbidity on the individual, their family members, caregivers, and the healthcare system itself[2,3].

Thus, individuals with multimorbidity require a wide range of care aimed at understanding the unique complexity that encompasses each reality[4]. In this regard, social determinants have gained prominence in the literature in recent decades, given the need to address inequalities that affect access to the universal right to health[5]. Among these, one can cite education, the various conditions of access to health information, management of lifestyle habits, and self-care[6,7].

In addition to health-related repercussions, a Dutch study estimated a significant increase in healthcare costs for individuals with multimorbidity compared to those with only one chronic disease[8]. Therefore, it is believed that the factors affecting health conditions and their repercussions may vary over time due to different levels of information, changes in healthcare, shifts in health policies, which would necessitate periodic reassessments of public health policies.

Hence, this study aims to analyze the factors associated with the multimorbidity condition among individuals aged 60 to 69 years in 2010 and 2021, establishing a comparative analysis of the reality within the same age group.

## METHODS

This is a comparative cross-sectional study between the years 2010 and 2021, census-based, conducted using the same methodology, targeting the older population residing in the municipality of Coxilha, Rio Grande do Sul (RS), Brazil.For these studies, individuals aged 60 to 69 years were analyzed in the years 2010 and 2021. Data collection was conducted individually by trained interviewers through household surveys using a structured questionnaire administered to older adults.

The baseline of the study took place in the year 2010, during which, according to data from the Brazilian Institute of Geography and Statistics (IBGE - Instituto Brasileiro de Geografia e Estatística) census of 2010, the municipality had a Human Development Index (HDI) of 0.706 and a population of approximately 2,800 inhabitants, of which 352 individuals were older adults. In the baseline, there was a loss of 5.6%, attributed to refusals to participate in the research or participants not being found after three attempted visits, totaling 332 older individuals. Of these, 192 were included for being aged between 60 and 69 years. In the year 2021, 520 older individuals were evaluated, of which 302 were included for being aged between 60 and 69 years.

The outcome variable, multimorbidity, was defined as the presence of two or more chronic diseases in an individual[1]. For this purpose, the self-reported presence of ten chronic diseases was analyzed: rheumatism, chronic obstructive pulmonary disease (COPD), systemic arterial hypertension, diabetes mellitus, stroke, arthritis/osteoarthritis, heart problems, cancer, Parkinson's disease, and Alzheimer's disease.

The sociodemographic variables analyzed included sex, race, marital status, income, education, and residential area. Functional capacity was assessed by analyzing basic and instrumental activities of daily living, for which an adapted version of the Lawton and Katz scales was used, with adaptations made through grouping of responses.Older individuals were considered dependent for Activities of Daily Living (ADL) if they reported experiencing significant difficulty, inability, or needing assistance with feeding, dressing, grooming, getting in and out of bed, using the toilet, and/or moving around. Similarly, older adults were classified as dependent for Instrumental Activities of Daily Living (IADL) if they experienced significant difficulty, were unable to perform, or required assistance with walking on flat ground, climbing stairs, transferring from chair to bed and vice versa, walking near home, taking medication on

time, trimming toenails, using public transportation, managing finances, and/or leaving home[9].

For the descriptive analysis, absolute and simple relative frequencies were calculated. For bivariate inferential analysis (Fisher's Exact Test and chi-square test) and multivariate analysis, the Poisson regression test with robust variance was performed. For the multivariate analysis, the stepwise backward selection procedure was employed, meaning that variables with $p < 0.20$ were included in the regression model, and then variables were removed one by one as they lost statistical significance. The significance level considered was $p < 0.05\%$.

The baseline study was approved by the Research Ethics Committee of the Universidade de Passo Fundo under Opinion 148/2010. Similarly, the second wave of the research was submitted to the Research Ethics Committee of the Universidade de Passo Fundo and approved under Opinion Number 4,586,122. All study participants will be preserved through the Free and Informed Consent Form.

## DATA AVAILABILITY

The entire data set supporting the results of this study is available upon request to corresponding author Emanuelly Casal Bortoluzzi.

## RESULTS

A total of 192 older individuals were analyzed in the year 2010, while in the year 2021, 302 older individuals in the age range of 60 to 69 years were included in the study. Table 1 presents sociodemographic and health variables, including their prevalence and statistical differences between the two analyzed time points. A significant decrease in older adults with multimorbidity within the same age group is observed among those who cannot read, are illiterate, or have lower levels of education, as well as among those dependent on basic and instrumental activities of daily living (ADL and IADL, respectively), and older individuals who continue working.



In Table 2, the bivariate analysis regarding factors associated with multimorbidity among older adults aged 60 to 69 years in the years 2010 and 2021 is presented. It is observed that dependency on basic and instrumental activities of daily living, as well as not having employment, emerged as associated factors with multimorbidity in both periods. However, in the year 2021, variables such as gender, income, literacy, and residential area are added as factors associated with the presence of multimorbidity.

In the multivariate analysis, which included variables with significance values $\leq 0.20$ in the bivariate analysis, the outcome highlighted being dependent for IADL with the highest prevalence of multimorbidity. In the year 2010, in addition to dependence for IADL, being dependent on ADL also showed an association with a higher prevalence of multimorbidity. Among older adults aged 60 to 69 in 2021, not working and not knowing how to read and write increased the prevalence of multimorbidity by 1.15 and 1.26 times, respectively.

**Table 1.** Bivariate analysis, through Poisson Regression, of the investigated variables in older individuals aged 60 to 69 years in 2010 (first wave) and 2021 (second wave).

| Variables | 2010<br>n (%) | 2021<br>n (%) | *p* |
|---|---|---|---|
| Multimorbidity | | | **<0.001** |
| Yes | 127 (66.5) | 123 (41.6) | |
| No | 64 (33.5) | 173 (58.4) | |
| Sex | | | 0.134 |
| Male | 101 (52.6) | 138 (45.7) | |
| Female | 91 (47.4) | 164 (54.3) | |
| Skin color | | | 0.124 |
| White | 133 (69.3) | 223 (75.6) | |
| Non-white | 59 (30.7) | 74 (24.4) | |
| Marital status | | | 0.262 |
| Without partner | 42 (21.9) | 78 (26.4) | |
| With partner | 150 (78.1) | 218 (73.6) | |
| Total income (MW) | | | 0.497 |
| Up to 2 | 141 (76.6) | 213 (72.4) | |
| 3 to 5 | 31 (16.8) | 54 (18.4) | |
| 5 or more | 12 (6.5) | 27 (9.2) | |
| Retirement | | | 0.092 |
| No | 42 (21.9) | 85 (28.7) | |
| Yes | 150 (78.1) | 211 (71.3) | |
| Able to read and write | | | **<0.001** |
| Yes | 157 (81.8) | 275 (92.9) | |
| No | 35 (18.2) | 21 (7.1) | |
| Education (years of schooling) | | | **<0.001** |
| Illiterate - up to 3 | 83 (43.7) | 40 (13.6) | |
| 4 to 7 | 90 (47.4) | 232 (78.6) | |
| 8 or more | 17 (8.9) | 23 (7.8) | |
| Performs ADL | | | **<0.001** |
| Independent | 134 (70.2) | 291 (98.3) | |
| Dependent | 57 (29.8) | 5 (1.7) | |
| Performs IADL | | | <0.001 |
| Independent | 55 (28.8) | 249 (85.0) | |
| Dependent | 136 (71.2) | 44 (15.0) | |
| Residential area | | | 0.066 |
| Urban | 112 (58.3) | 197 (66.6) | |
| Rural | 80 (41.7) | 99 (33.4) | |
| Currently employed | | | **0.001** |
| Yes | 97 (50.5) | 106 (35.8) | |
| No | 95 (49.5) | 190 (64.4) | |

MW: Minimum Wages; ADL: Activities of Daily Living; IADL: Instrumental Activities of Daily Living.

**Table 2.** Multivariate analysis, using Poisson Regression, of sociodemographic and health variables according to multimorbidity among older adults aged 60 to 69 years. (2010 n=192; 2021 n=302)

| Variables | Multimorbidity Age group 60 to 69 years in 2010 | | PR 95% CI) | *p* | Multimorbidity Age group 60 to 69 years in 2021 | | PR (95% CI) | *p* |
|---|---|---|---|---|---|---|---|---|
| | YES n (%) | NO n (%) | | | YES n (%) | NO n (%) | | |
| Sex | | | | | | | | |
| Male | 61 (61.0) | 39 (39.0) | 1 | | 46 (33.8) | 90 (66.2) | 1 | |
| Female | 66 (72.5) | 25 (27.5) | 0.89 (0.78-1.02) | 0.088 | 79 (48.5) | 84 (51.5) | 1.56 (1.04-1.30) | **0.009** |
| Skin color | | | | | | | | |
| White | 87 (65.9) | 45 (34.1) | 1 | | 92 (41.1) | 132 (58.9) | 1 | 0.596 |
| Non-white | 40 (67.8) | 19 (32.2) | 1.02 (0.88-1.18) | 0.797 | 33 (44.6) | 41 (55.4) | 1.04 (0.91-1.18) | |
| Marital status | | | | | | | | |
| Without partner | 27 (64.3) | 15 (35.7) | 1 | | 37 (46.8) | 42 (53.2) | 1 | 0.294 |
| With partner | 100 (67.1) | 49 (32.9) | 1.03 (0.87-1.21) | 0.734 | 88 (40.0) | 132 (60.0) | 0.93 (0.82-1.06) | |
| Total income (MW) | | | | | | | | |
| Up to 2 | 92 (45.1) | 48 (34.3) | 1 | | 101 (47.0) | 114 (53.0) | 1 | |
| 3 to 5 | 29 (67.4) | 14 (32.6) | 1.02 (0.86-1.19) | 0.833 | 14 (25.5) | 41 (74.5) | 0.81 (0.71-0.92) | **0.002** |
| 5 or more | - | - | - | | 9 (33.3) | 18 (66.7) | 0.87 (0.72-1.05) | 0.159 |
| Retirement | | | | | | | | |
| No | 30 (71.4) | 12 (28.6) | 1 | 0.428 | 37 (43.0) | 49 (57.0) | 1 | 0.787 |
| Yes | 97 (65.1) | 52 (34.9) | 0.94 (0.80-1.09) | | 88 (41.3) | 125 (58.7) | 0.98 (0.87-1.11) | |
| Able to read and write | | | | | | | | |
| Yes | 105 (66.9) | 52 (33.1) | 1 | | 109 (39.5) | 167 (60.5) | 1 | **0.003** |
| No | 22 (64.7) | 12 (35.3) | 0.98 (0.82-1.17) | 0.810 | 16 (69.6) | 7 (30.4) | 1.35 (1.11-1.64) | |
| Education (years of schooling) | | | | | | | | |
| Illiterate - up to 3 | 52 (63.4) | 30 (36.6) | 1 | | 21 (50.0) | 21 (50.0) | 1 | |
| 4 to 7 | 65 (72.2) | 25 (27.8) | 1.09 (0.95-1.25) | 0.216 | 76 (42.0) | 105 (58.0) | 0.92 (0.78-1.09) | 0.348 |
| 8 or more | 9 (52.9) | 8 (47.1) | 0.90 (0.69-1.18) | 0.428 | 28 (37.3) | 47 (62.7) | 0.88 (0.73-1.06) | 0.184 |
| Performs ADL | | | | | | | | |
| Independent | 111 (63.8) | 63 (36.2) | 1 | | 113 (39.8) | 171 (60.2) | 1 | |
| Dependent | 15 (93.8) | 1 (6.3) | 1.26 (1.10-1.43) | **0.001** | 12 (80.0) | 3 (20.0) | 1.50 (1.21-1.84) | **<0.001** |
| Performs IADL | | | | | | | | |
| Independent | 52 (53.6) | 45 (46.4) | 1 | | 74 (33.0) | 150 (67.0) | 1 | |
| Dependent | 75 (79.8) | 19 (20.2) | 1.45 (1.25-1.69) | **>0.001** | 50 (68.5) | 23 (31.5) | 1.43 (1.26-1.61) | **<0.001** |
| Residential area | | | | | | | | |
| Urban | 77 (69.4) | 34 (30.6) | 1 | | 94 (47.2) | 105 (52.8) | 1.18 (1.05-1.32) | **0.005** |
| Rural | 50 (62.5) | 30 (37.5) | 1.08 (0.93-1.23) | 0.324 | 31 (31.0) | 69 (69.0) | 1 | |
| Currently employed | | | | | | | | |
| Yes | 58 (59.8) | 39 (40.2) | 1 | | 29 (27.1) | 78 (72.9) | 1.26 (1.13-1.40) | **<0.001** |
| No | 69 (73.4) | 25 (26.6) | 1.15 (1.00-1.31) | **0.044** | 96 (50.0) | 96 (50.0) | 1 | |

MW: Minimum Wages; ADL: Activities of Daily Living; IADL: Instrumental Activities of Daily Living.

**Table 3**. Final adjusted prevalence ratio model, using Poisson Regression with robust variance, for factors associated with multimorbidity among older adults aged 60 to 69 years in the year 2010. (n=192) e 2021 (n=302).

| Variables | Multimorbidity | | | |
|---|---|---|---|---|
| | Age group 60 to 69 years in 2010 | | Age group 60 to 69 years in 2021 | |
| | $PR_{Adjusted}$(95% CI) | p | $PR_{Adjusted}$(95% CI) | p |
| Performs ADL | | | | |
| Independent | 1 | | | |
| Dependent | 1.18 (1.02 - 1.38) | 0.029 | | |
| Performs IADL | | | | |
| Independent | 1 | | 1 | |
| Dependent | 1.27 (1.10 - 1.45) | 0.001 | 1.36 (1.19-1.55) | <0.001 |
| Able to read and write | | | | |
| Yes | | | 1 | |
| No | | | 1.26 (1.03-1.55) | 0.025 |
| Currently employed | | | | |
| Yes | | | 1 | |
| No | | | 1.15 (1.02-1.29) | 0.021 |

ADL: Activities of Daily Living; IADL: Instrumental Activities of Daily Living.

## DISCUSSION

The present study presents the profile and comparison of the investigated characteristics among older adults aged 60 to 69 years, in the years 2010 and 2021. Being dependent on Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL), as well as not being literate, showed significantly higher prevalence in the year 2010. However, in the year 2021, being dependent on ADL, not being literate, and not being employed were associated with a higher prevalence of multimorbidity. These findings point to the need for adaptation of public health policies according to the specific context of each moment, recognizing that even within the same geographical and sociocultural context, determinants change across generations and this should be taken into account.

It is noteworthy that the population exhibits a significant difference in multimorbidity prevalence, showing higher prevalence in 2010. Furthermore, it is indicated that the percentage of older adults who are illiterate, dependent on ADL and IADL, and who remain in the workforce, was lower in 2021 compared to the reality observed in 2010. Similarly, in the present study, in contrast to the literature, income did not show significance regarding multimorbidity[3,15,16]. This reinforces that in the present study, educational level was a determining factor, unlike income reported by the individual.

The lack of association between dependency on ADL and multimorbidity in the year 2021 may be explained by the better health condition of older adults in this age group during the second wave of the survey, a hypothesis strengthened by the significantly lower prevalence of multimorbidity among the population compared to older adults in the year 2010. As for instrumental activities, they were present in both contexts, which can be justified by the greater complexity of these tasks compared to basic activities[10].

Consequently, the presence of dependency on instrumental activities can be a limiting factor for maintaining employment. Even among retired older adults, it is common, especially among those within the studied age group, for them to continue engaging in employment activities despite the decline in physical capacity[11]. In this aspect, one can

even point out factors that are constantly debated in relation to public pension services, where the greater life expectancy is countered by the more frequent physical and mental repercussions among older adults, recognizing the interrelation between physical and social aspects[12-14].

In the present study, it was evident that not being literate is a factor significantly associated with a higher prevalence of multimorbidity among the investigated older adults in the year 2021. This interrelation between factors can be corroborated by the study of Chen et al.[8] which indicates that multimorbidity affects individuals with lower educational attainment more severely, with the negative impact on activities of daily living being about three times greater in individuals with lower educational attainment. Regarding education, it is recognized as a variable that consistently influences health-related aspects[7,15-17].

Illiteracy or lower educational attainment can be associated with greater difficulty in understanding and performing healthcare tasks and adopting habits that promote prevention and control of chronic diseases, such as engaging in physical activity and controlling body weight[19].

It is worth noting that the significant decrease in illiterate older adults found in the present study, as described in the literature[20], demonstrates a possible effective improvement in educational public policies, which are known to have positive repercussions on public health policies[21]. This allows individuals to have greater chances of engaging in more adequate self-health management, whether in terms of lifestyle habits or the correct utilization of medications.

It should be mentioned that the data collection period in 2021 coincides with the Covid-19 pandemic, which has been recognized to have significant repercussions on public health worldwide. Studies indicate that older population and those with multimorbidity have shown higher mortality rates[22], which may have influenced a lower prevalence of the condition studied in the 2021 conducted study. Considering this hypothesis strengthens the justification for the relevance of knowledge about multimorbidity and its associated factors, upon which it is possible to act regarding prevention and control, thereby enabling an improvement in the health conditions of older adults.

The study identified the primary limitation as the use of self-reported information, which may lead to underreporting of certain conditions. However, it is worth highlighting that this is a census-based, population-based study with a wide range of information, conducted at two different time points, a fact that enables more precise information about the target population.



## CONCLUSION

The present study concludes that among older adults aged 60 to 69 years in 2010, dependency on basic and instrumental activities of daily living was associated with multimorbidity. In this same age group in 2021, being dependent on instrumental activities of daily living, being unable to read and write, and not being employed were the conditions found to be associated with multimorbidity.

Analyzing small-sized municipalities enables a broader and more intricate analysis, as executed in this census-based study, thereby providing insights into changes in health conditions over time. It is hoped that the results and the initiative to study older adults residing in small-sized municipalities will serve as encouragement for future research endeavors, considering that the majority of studies focus on large urban centers, a reality that may not represent everyone. Such studies can contribute to reducing the prevalence of multimorbidity through actions addressing associated factors. Furthermore, understanding the reality of younger older adults allows for interventions aimed at prevention and improving quality of life in subsequent age groups.

## AUTHORSHIP

- Emanuelly Casal Bortoluzzi was the main author of the article, which is part of her thesis, participated in data collection, data analysis, writing the manuscript and approval of the version to be published;

- Andreia Mascarelo collected data from the first wave and participated in data collection from the second wave of the study, participated in the process of structuring the analysis objectives;
- Marilene Rodriegues Portella participated in data collection from the first and second waves, helped throughout the article construction process;
- Shana Ginar da Silva assisted in the entire process of reviewing and adjusting the writing of the article throughout the process, co-supervised the thesis that led to this study and approved the version to be published;
- Ana Luisa S. Alves organized the data collection process for the second wave of the study, supervised the thesis that originated this study, reviewed and guided the entire process and approved the version to be published;



## ACKNOWLEDGMENT

This work was carried out with the support of the Coordination for the Improvement of Higher Education Personnel – Brazil (CAPES) – funding code 001.

Edited by: Isac Davidson S. F. Pimenta

## REFERENCES

1. Marengoni A, Angleman S, Melis R, et al. Aging with multimorbidity: a systematic review of the literature. Ageing research reviews. 2011;10(4):430-439. Available at: https://doi.org/10.1016/j.arr.2011.03.003
2. Chudasama YV, Khunti K, Gillies CL, et al. Healthy lifestyle and life expectancy in people with multimorbidity in the UK Biobank: A longitudinal cohort study. PLoS Med., 2020;17(9):e1003332.Available at: https://doi.org/10.1371/journal.pmed.1003332
3. Barnett K, Mercer SW, Norbury M, et al. Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study. Lancet, 2012;380(9836),37–43.Available at: https://doi.org/10.1016/S0140-6736(12)60240-2.
4. Mitchell KB, Bartell S. Multimorbidity and Resident Education. Fam Med., 2021;53(7):531-534. Available at: https://doi.org/10.22454/FamMed.2021.106319.
5. Pellegrini Filho A. Public policy and the social determinants of health: the challenge of the production and use of scientific evidence. Cadernos de Saúde Pública, 2011;27(1):s135–s140. Available at: https://doi.org/10.1590/S0102-311X2011001400002.
6. Silva DSMD, Assumpção DD, Francisco PMSB, et al. Doenças crônicas não transmissíveis considerando determinantes sociodemográficos em coorte de idosos. Revista Brasileira de Geriatria e Gerontologia, 2022; 25(5):e210204. Available at: https://doi.org/10.1590/1981-22562022025.210204.pt.
7. Costa ÂK, Bertoldi AD, Fontanella AT, et al. Does socioeconomic inequality occur in the multimorbidity among Brazilian adults? Rev Saude Publica, 2020; 54(1):138-149. Available at: https://doi.org/10.11606/s1518-8787.2020054002569.
8. Chen YH, Karimi M, Rutten-van Mölken MP. The disease burden of multimorbidity and its interaction with educational level. PLoSOne.2020; 15(12): e0243275. Available at: https://doi.org/10.1371/journal.pone.0243275.
9. MASCARELLO, A. Condições de vida e saúde dos idosos no município de Coxilha-RS [dissertação de mestrado]. Passo Fundo (Brasil): Universidade de Passo Fundo, Programa de Pós Graduação em Envelhecimento Humano; 2012. 132 p. Available at: http://tede.upf.br/jspui/bitstream/tede/1091/1/2012Andreia_Mascarelo.pdf.
10. Qian J, Ren X. Association between comorbid conditions and BADL/IADL disability in hypertension patients over age 45: Based on the China health and retirement longitudinal study (CHARLS). Medicine(Baltimore), 2016; 95(31): e4536. Available at: https://doi.org/10.1097/MD.0000000000004536.
11. Pinto AH, Lange C, Pastore CA, et al. Capacidade funcional para atividades da vida diária de idosos da Estratégia de Saúde da Família da zona rural. Ciência & Saúde Coletiva, 2016; 21(11): 3545–3555. Available at: https://doi.org/10.1590/1413-812320152111.22182015.

12. Gómez F, Osorio-García D, Panesso L, et al. Healthy aging determinants and disability among older adults: SABE Colombia. Revista Panamericana de Salud Pública, 2021; 45(1): 1-9. Available at: https://doi.org/10.26633/RPSP.2021.98.

13. Ci Z. Does raising retirement age lead to a healthier transition to retirement? Evidence from the US Social Security Amendments of 1983. Health Economics, 2022; 31(10): 2229-2243. Available at: https://doi.org/10.1002/hec.4572.

14. YuanB,ZhangT,LiJ. Late-life working participation and mental health risk of retirement-aged workers: How much impact will there be from social security system?. Journal of Occupational and Environmental Medicine, 2022; 64(7):e409-e416. Available at: https://doi.org/10.1097/JOM.0000000000002561.

15. Andrade BF, Thumé E, Facchini LA, et al. Education and income-related inequalities in multimorbidity among older Brazilian adults. PLoSOne, 2022; 17(10):e0275985. Available at: https://doi.org/10.1371/journal.pone.0275985.

16. Knies G, Kumari M. Multimorbidity is associated with the income, education, employment and health domains of area-level deprivation in adult residents in the UK. Sci Rep., 2022;12(1):7280. Available at: https://doi.org/s41598-022-11310-9.

17. Nascimento-Souza MA, Firmo JOA, Souza Júnior PRBD, etal. Sociodemographic and residential factors associated with multimorbity: results of Brumadinho Health Project. Revista Brasileira de Epidemiologia, 2022; 25(1): e220006. Available at: https://doi.org/10.1590/1980-549720220006.supl.2.

18. Chudasama YV, Khunti KK, Zaccardi F, et al. Physical activity, multimorbidity, and life expectancy: a UK Biobank longitudinal study. BMC Med., 2019; 17(1):108-120. Available at: https://doi.org/10.1186/s12916-019-1339-0.

19. Kivimäki M, Strandberg T, Pentti J, et al. Body-mass index and risk of obesity-related complex multimorbidity: an observational multicohort study. Lancet Diabetes Endocrinol., 2022; 10(4): 253-263. Available at: https://doi.org/10.1016/S2213-8587(22)00033-X.

20. Macinko J, Mullachery PH. Iniquidades em saúde relacionadas à educação em doenças não transmissíveis: uma análise da Pesquisa Nacional de Saúde, 2013 e 2019. Cadernos de Saúde Pública, 2022; 38(1): e00137721. Available at: https://doi.org/10.1590/0102-311X00137721.

21. França T, Magnago C. Políticas, programas e ações de educação na saúde: perspectivas e desafios. Saúde em Debate, 2019; 43(spe1): 4–7. Available at: https://doi.org/10.1590/0103-11042019S100.

22. Muraro AP, Rocha R, Boing AC, et al. Óbitos por condições de saúde posteriores à COVID-19 no Brasil. Ciência&Saúde Coletiva, 2023; 28(2):331–336. Available at: https://doi.org/10.1590/1413-81232023282.16752022.