

## ORIGINAL RESEARCH

### Aging in a rural area in southern Brazil: designing a prospective cohort study

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## ABSTRACT:

**Introduction:** This article presents the methods used to design a prospective cohort study with older adults from a rural area in the far south of Brazil (EpiRural Cohort Study), as well as to describe the cohort profile.

**Methods:** The cohort study began in 2017 and evaluated older adults ( $\geq 60$  years) living in rural area. The first follow-up of the cohort was carried out between September 2018 and March 2019. Data collection at baseline and first follow-up was performed through an electronic questionnaire containing demographic, socioeconomic and health-related questions, such as alcohol and cigarette consumption, morbidities and self-perceived health status.

**Results:** At baseline, 1130 older adults were sampled, 1029 of whom were interviewed (91.1%). The age of almost 17% was 80 years or more, and 55.2% were male. At first follow-up,

**Keywords:**

aging, Brazil, cohort studies, epidemiology, older adults, rural population.

862 individuals were followed (83.8%) and the characteristics of the older adults interviewed compared to those not interviewed at follow-up were similar. Between baseline and follow-up, the proportion of individuals aged 70–79 years increased, as well as the proportion of those who had consumed alcoholic beverages in the previous week and who had hypertension. The male-to-female ratio, those who were living alone, working, smokers, diabetics, who had stroke and who reported their health as being very good/good were comparable between the baseline and follow-up.

**Conclusion:** With a reasonable follow-up rate, it was possible to transform a cross-sectional study into a prospective cohort study. However, new strategies will be needed to help locate participants more successfully and ensure a good response rate in future follow-ups.

## FULL ARTICLE:

### Introduction

Population aging is a global phenomenon characterized by an increasing proportion of older adults in the population, attributed to decreasing mortality and birth rates<sup>1</sup>. Brazil is rapidly becoming an aged country – of more than 213 million inhabitants, nearly 30 million are older adults (aged 60 years or more). Nearly 4.5 million (15%) Brazilian older adults live in rural areas. Despite the advances in primary healthcare coverage in Brazilian rural areas, provision of adequate health services for rural populations is particularly challenging. The economic and political crisis and Constitutional Amendment 95<sup>2</sup> have further restricted investments in the Brazilian Unified Health System<sup>3</sup>. This situation constitutes a threat to integrality and equity in health care, compromising investments in the Family Health Strategy, which is a user's first contact with the health system. This scenario can compromise recent efforts to expand coverage and maintenance of health teams in rural and remote localities.

Most literature on aging has been produced in rich countries and in urban areas. Since the determinants of aging can be affected by local conditions, particularly the reduced supply of health services, it may not be appropriate to apply results of urban studies to help propose and implement measures to improve the health care of older adults living in rural areas. In Brazil, urban space is determined by municipal law, and rural space is defined by the exclusion of the urban area. Taking this classification, according to

the 2010 Census 84.4% of Brazil's population at that time were living in urban areas and 15.6% in rural areas<sup>4-6</sup>.

Knowledge about the occurrence of falls, frailty, sarcopenia and vulnerability among older adults in rural areas of Brazil is less than that available about their urban counterparts<sup>7-9</sup>. Longitudinal cohort studies that accompany older adults from rural areas can measure the occurrence of diseases as well as assist health service managers in proposing measures that could improve the health services offered according to the needs of rural inhabitants. Thus, this study aims to present the methods used to design a prospective cohort study with older adults from a rural area in the far south of Brazil (EpiRural Cohort Study), as well as to describe the cohort profile.

### Methods

#### Study area

Rio Grande is a municipality in the south of Rio Grande do Sul state, Brazil, with an area of approximately 2708 km<sup>2</sup>. It has one of the largest ports in Brazil and, in 2017, its estimated population was 209 378, almost 95% of whom lived in urban areas<sup>4,5</sup>. The rural part of the municipality of Rio Grande is geographically delimited by the water bodies Laguna dos Patos, the Atlantic Ocean and Laguna Mirim, where traditional communities live mainly from fishing and family farming, including livestock, rice and soybean. The study area was chosen to:

- locate the study in the same municipality as that of the EpiRural Cohort Study, designed and developed by researchers from the Federal University of Rio Grande
- investigate and monitor patterns of morbidity, mortality and use of health services in a poorly studied population.

### Study population

The eligible population for the EpiRural Cohort Study comprised older adults (aged  $\geq 60$  years) living in the rural area of the municipality of Rio Grande.

### Baseline survey

The baseline survey was originally a cross-sectional study conducted from April to October 2017. A systematic random sampling process was used to select 80% of households. For each census tract, a number between 1 and 5 was drawn, with the drawn number corresponding to the household in each group of five consecutive households that was skipped. This procedure

ensured that four out of five households were sampled in each census tract. All individuals aged 60 years or more who lived in the selected households were eligible. Individuals living in long-stay institutions, nursing homes and prisons were excluded.

The baseline questionnaire included questions about demographic and socioeconomic characteristics (gender, age, ethnicity, religion, marital status, education, family income and occupational status) and lifestyle (smoking, alcohol consumption), as well as about health conditions (self-rated health, past medical history of hypertension, diabetes, stroke, osteoarthritis and lung disease), falls and medication use. The Katz Index of Independence in Activities of Daily Living (ADL)<sup>10</sup>, the Lawton Instrumental Activities of Daily Living Scale (IADL)<sup>11</sup>, the Patient Health Questionnaire (PHQ-9)<sup>12</sup>, the Measure of Older Adults Sedentary Time (MOST)<sup>13</sup>, the short version of the Brazilian Food Insecurity Scale (EBIA)<sup>14</sup> and the Eating Behavior Questionnaire (adapted from the SABE Study)<sup>15</sup> were also applied. Weight and height were self-reported by the individuals (Table 1).

**Table 1: Summary of variables collected at baseline (2017) and first follow-up (2018/2019), EpiRural Cohort Study, Rio Grande, Rio Grande do Sul, Brazil**

Variable <sup>†</sup>	Baseline	First follow-up (2018/2019)
Sociodemographic	Sex, age, education, marital status, economic status, family income, occupation, skin color, marital status, religion and participation in social programs	Sex, age, education, family income, economic status, occupation, marital status and participation in social programs
Living/housing conditions	Type of construction, ownership of the residence, number of rooms, rooms used for sleeping, mains water supply, presence of bathroom and type of sewage system	Ownership of residence, number of rooms, rooms used for sleeping, mains water supply, presence of bathroom and type of sewerage system
Rural labor activity	Not investigated	Fishing and agriculture
Rural production	Animal husbandry and planting on the property	Animal husbandry and planting on the property
Exposure to pesticides	Not investigated	Current and previous
Medical history and disease	Past history, family history, current illnesses, history of amputation, urinary incontinence and parity (for women)	Current illnesses, vision problems, hearing, urine loss/ urinary incontinence and body pain
Health service	Access to and use of health service, flu vaccine	Access to and use of health service, flu vaccine and private health insurance
Oral health	Number of teeth, presence of prostheses, consultation with a dentist and dental insurance	Number of teeth, presence of prostheses, consultation with a dentist, private dental insurance and oral health related quality of life (OHIP14)
Mental health	Depression (PHQ-9)	Not investigated
Functional dependence	Activities of Daily Living (Katz Index) and Instrumental Activities of Daily Living (Lawton and Brody's Scale)	Not investigated
Cognitive function	Not investigated	Cognitive impairment (MMSE)
Vulnerability	Not investigated	Vulnerability (VES-13)
Sarcopenia	Not investigated	Sarcopenia (SARC-F and SARC-Calf)
Medicines	Use, type, expenses and access	Use, type, expenses and access
Health-related behaviors	Smoking, drinking, diet, sleep and sedentary behavior (MOST)	Smoking and drinking
Nutrition	Food insecurity (EBIA), healthy nutrition habits and access (based on the Dietary Guidelines for the Brazilian population) or Eating Behavior Questionnaire	Not investigated
Social activities	Leisure activity	Not investigated
Additional items	Sleep, falls and flu vaccine	Falls, flu vaccine and home safety fall prevention
Anthropometric measures	Height and weight	Height, weight, calf circumference and knee height

<sup>†</sup> All variables shown were collected by questionnaire/interview. Exception was first follow-up anthropometric measurements, which were taken by examination. EBIA, Brazilian Food Insecurity Scale. MMSE, Mini Mental State Examination. MOST, Measure of Older Adults Sedentary Time. OHIP, Oral Health Impact Profile. PHQ, Patient Health Questionnaire. SARC-Calf, Calf Circumference questionnaire. SARC-F, Strength, Assistance with walking, Rise from a chair, Climb stairs and Falls questionnaire. VES, Vulnerable Elders Survey.

### First follow-up

From September 2018 to March 2019, the research team undertook the first annual follow-up visit at each participant's home. The questionnaire included the same information as the baseline instruments. In addition, the following were administered: the Oral Health Impact Profile (OHIP14)<sup>16</sup>; the Mini Mental State Examination (MMSE)<sup>17</sup>; the Vulnerable Elders Survey (VES-13)<sup>18</sup>; the Strength, Assistance with walking, Rise from a chair, Climb stairs and Falls (SARC-F) questionnaire<sup>19</sup>; and the Calf Circumference (SARC-Calf) questionnaire<sup>20</sup>. Knee height, weight and calf circumference measurements were performed. Body weight was measured with an Ohron digital scale, knee height was measured with a portable metal children's anthropometer and calf

circumference was measured with a non-stretch Cescorf tape measure.

Data collection instruments used at baseline and first follow-up comprised an electronic questionnaire using REDCap (Research Electronic Data Capture)<sup>21</sup>. Both data collections were performed by a team of trained interviewers who had completed secondary school. All measurements were collected by professionals who had been trained according to Lohman's techniques<sup>22</sup> and were standardized as proposed by Habicht<sup>23</sup>.

### Death monitoring

Deaths are being continuously monitored from a monthly report of death certificates or by consulting the Mortality Information

System (SIM) at the Municipal Epidemiological Surveillance System. Causes of deaths are being coded according to the *International Classification of Diseases*, 10th revision (ICD-10)<sup>24</sup>.

### Data analysis

Data were analyzed using Stata v13 (StataCorp; <http://www.stata.com>). Baseline and first follow-up were described according to sociodemographic, behavioral and health characteristics. The research team then compared the profiles of respondents and non-respondents from the first follow-up (sex, age, smoking, alcohol consumption, diagnosis of hypertension, diabetes, stroke and self-rated health). Pearson's chi-square  $\chi^2$  test was used for both analyses.

### Ethics approval

The baseline and the first follow-up studies were approved by the Research Ethics Committee of the Federal University of Rio Grande, as per opinion numbers 51/2017 and 154/2018, respectively.

Confidentiality of the participants' individual information was ensured. Participants signed an informed consent form. Caregivers or legal guardians signed the form on behalf of elderly people with disabilities where required.

## Results

### Baseline

The research team sampled 763 households with 1130 older adults; 1029 individuals participated in the baseline study (8.9% lost to follow-up and refusals).

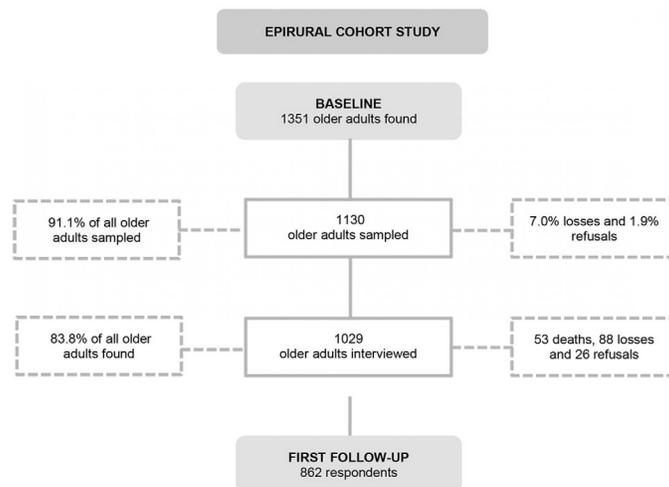
### First follow-up

From the original cohort, 862 individuals were followed (83.8%) in the first follow-up, 2018/2019 (Fig1). Respondents did not differ from non-respondents regarding sex, age, smoking, alcohol consumption, diabetes and stroke. A larger number of non-hypertensive individuals were lost to follow-up (Table 1).

**Table 2: Respondents and non-respondents at first follow-up (2018/2019), EpiRural Cohort Study, Rio Grande, Rio Grande do Sul, Brazil**

Variable	Respondents		Non-respondents		p <sup>†</sup>
	n	%	n	%	
Sex					0.10
Male	466	82.0	102	18.0	
Female	396	85.9	64	14.1	
Age (years)					0.55
60–69	438	82.9	89	17.1	
70–79	280	85.6	47	14.4	
≥80	144	82.8	30	17.2	
Smoking					0.78
Never smoked	460	84.6	84	15.4	
Former smoker	290	83.3	58	16.7	
Smoker	112	82.3	24	17.7	
Alcoholic drink in previous week					0.98
No	718	83.8	138	16.2	
Yes	144	83.7	28	16.3	
Hypertension diagnosis					0.01
No	374	80.6	89	19.4	
Yes	487	86.3	77	13.7	
Diabetes diagnosis					0.12
No	732	84.5	133	15.5	
Yes	128	79.5	33	20.5	
Stroke diagnosis					0.60
No	800	83.9	152	16.1	
Yes	62	81.6	14	18.4	
Self-reported health					0.35
Very good/good	502	85.1	88	14.9	
Regular	295	82.6	62	17.4	
Poor/very poor	62	79.5	16	20.5	

<sup>†</sup>  $\chi^2$  test.



**Figure 1: Flow diagram indicating the number of elderly identified, sampled, losses and refusals of the EpiRural Cohort Study, 2017 and 2018/2019**

### Cohort profile

In the baseline study, most individuals were males (55.2%) and aged 60–69 years (51.4%). Almost 23.0% were living alone, 15.0% were working, about 13.2% were smokers and a 16.7% had consumed alcoholic beverages in the previous week. The prevalence rates of hypertension, diabetes and stroke were 54.9%, 15.7% and 7.4%, respectively. About 60% classified their health as very good/good (Table 3).

Between the baseline and the follow-up study, the proportion of individuals aged 60–69 years decreased to 44.3% and those aged 70–79 years increased to 36.1%. Those who had consumed alcoholic beverages in the previous week and had hypertension increased to 19.4% and 59.0%, respectively. Male-to-female ratio, living alone, working, smoking, diabetes diagnosis, stroke and self-reported health were similar between baseline and first follow-up (Table 3).

**Table 3: Baseline and first follow-up characteristics of EpiRural Cohort Study in 2017 and 2018/2019, Rio Grande, Rio do Sul, Brazil**

Variable	Baseline (2017) (n=1029)			First follow-up (2018/2019) (n=862)		
	n <sup>†</sup>	%	95%CI	n <sup>†</sup>	%	95%CI
Sex						
Male	568	55.2	52.1–58.2	466	54.1	50.7–57.4
Female	461	44.8	41.8–47.9	396	45.9	42.6–49.3
Age (years)						
60–69	528	51.4	48.3–54.4	382	44.3	41.0–47.7
70–79	327	31.8	29.0–34.7	311	36.1	32.9–39.3
≥80	173	16.8	14.7–19.2	169	19.6	17.1–22.4
Living alone	233	22.6	20.2–25.3	184	21.7	19.1–24.6
Working	154	15.0	12.9–17.3	114	13.2	11.1–15.7
Smoking						
Never smoked	544	52.9	49.9–56.0	451	52.3	49.0–55.6
Former smoker	348	33.9	31.0–36.8	302	35.0	31.9–38.3
Smoker	136	13.2	11.3–15.4	109	12.7	10.6–15.0
Alcoholic drink in previous week	172	16.7	14.6–19.1	167	19.4	16.9–22.2
Hypertension diagnosis	564	54.9	51.8–57.9	507	59.0	55.6–62.2
Diabetes diagnosis	131	15.7	13.6–18.0	129	15.0	12.7–17.5
Stroke diagnosis	76	7.4	5.9–9.2	58	6.7	5.2–8.6
Self-reported health						
Very good/good	590	57.6	54.5–60.6	496	59.0	55.6–62.3
Regular	357	34.8	32.0–37.8	283	33.7	30.5–36.9
Poor/very poor	78	7.6	6.1–9.4	62	7.4	5.8–9.3

<sup>†</sup> Some variables have missing values  
CI, confidence interval.

### Discussion

This article describes the design and profile of a prospective cohort study with older adults from the rural area of the municipality of Rio Grande, Rio Grande do Sul state, Brazil. To the best of the authors' knowledge, the EpiRural Cohort Study is the first Brazilian rural older adults cohort. Most Brazilian longitudinal studies assessing older adults have been conducted in urban areas such as Bagé<sup>25</sup>, São Paulo<sup>15,26</sup> and Florianópolis<sup>27</sup>.

Prospective cohort studies with rural populations are scarce. In

Latin America, two cohort studies carried out in small rural towns in Chile (the San Francisco Project Cohort Study (PSF) and the Growth and Obesity Chilean Cohort Study (GOCS)) are noteworthy. The PSF population comprises individuals aged 30–79 years and aims to study and monitor cardiovascular risk factors, while the GOCS is a cohort study with children born in 2002–2003 that assesses the association between early postnatal growth and adiposity recovery time. PSF and GOCS are successful experiences of longitudinal studies carried out in rural areas of Latin America<sup>28,29</sup>.

In China, a country with almost 40% of its population living in rural areas<sup>30</sup>, two rural cohort studies that evaluate chronic non-communicable diseases (NCDs) in people aged 18 years or more were reported in the literature. The authors of those studies described that they measured outcomes such as stroke, coronary heart disease, diabetes, BMI and other common chronic NCDs. They also measured blood pressure, lung function and carried out imaging and blood exams<sup>31,32</sup>.

In the EpiRural Cohort Study, most NCDs have been measured. However, self-reported information about most morbidities has been used, and lung function, imaging and blood exams have not been performed (Table 1).

Data collection is organized and supervised by master's and doctoral students, who also perform the data analysis. Thus, the EpiRural Cohort Study is a useful tool for professional training while also producing scientific knowledge about the health of rural older individuals.

The authors have published 10 manuscripts with the baseline data. The findings are about access and use of healthcare services, depression, falls, food insecurity, functional dependence, obstructive apnea syndrome, sedentary behavior, smoking, urinary incontinence and oral health (Table 4)<sup>33-42</sup>. Manuscripts with the findings of the first follow-up have been submitted to a number of international scientific journals.

All the results were reported through meetings with primary healthcare managers and health professionals of the rural area of Rio Grande. Also, the main findings were described in a technical report handed over to the coordinators of family health centers of

the rural area of Rio Grande and to the municipal health department. The authors are also sharing the findings with the community on Facebook and Instagram (@epirural.riogrande).

This study has strengths and limitations. The sampling process enhances internal validity as the numbers/proportions of permanently inhabited households, men/women and age strata are similar to those reported by the Brazilian Institute of Geography and Statistics in the 2010 census. Follow-up rates are acceptable despite the challenge of conducting home interviews in rural localities. Losses to follow-up are mainly due to change of address. Sometimes the research team was unable to locate cohort members even after asking for help from neighbors and/or primary care health professionals. Moreover, some routes or localities were known by different names, and they were described better in our field diary to prevent more losses. In the second follow-up the research team will use a global positioning system device to record and locate households. The team is also working to improve data quality about sarcopenia through the measurement of hand grip strength with a dynamometer and walking speed. The use of self-reported diagnosis of hypertension and other morbidities is subject to recall bias. Thus, blood pressure measurements and other clinical tests were included to minimize this limitation. About 5% of cohort members died in a 12–18-month time interval. As an older adults cohort, future study will have to include new members to become a dynamic cohort study.

The EpiRural Cohort Study welcomes collaboration to enhance knowledge about rural older adults. Researchers interested in collaborating and/or further information are invited to contact the authors.

**Table 4: Summary of main publications of EpiRural Cohort Study, Rio Grande, Rio Grande do Sul, Brazil**

Outcome	Main results
Access and use of health services [ref 31]	61.4% considered the basic family health center to be a prime choice/reference service mostly due to its proximity (82.6%); the remainder sought other places due to greater ease (34.6%) and resolutive capacity (52.6%). The lower the age, income, education and household/health center distance, the greater the likelihood of the older adult considering the nearest basic family health center as their reference service.
Depression (Patient Health Questionnaire-9) [ref 32]	Prevalence of 8.1%. Women, with lower BMI, continuous drug users, with two or more chronic diseases and with a worse perception of health were more likely to develop depressive symptoms.
Falls [ref 33]	Prevalence of 25.3%. Female gender and being in the 70–79 and ≥80 years age ranges were associated with falls as well as those who self-rated their health as poor.
Food insecurity (Short version of the Brazilian Food Insecurity Scale) [ref 34]	Prevalence of 26%. The most affected domiciles were those in which the head of the household had less than four years of schooling, with more residents, without animal husbandry, belonging to the lowest income quartile and receiving family grants (Bolsa Familia program).
Functional dependence (Katz Index for Activities of Daily Living and Lawton and Brody's Scale for Instrumental Activities of Daily Living) [ref 35]	Prevalence of functional dependence in ADL was 8.1% and in IADL it was 32.4%. Being female, older, having less schooling, diabetes, urinary incontinence, stroke and poor/very poor self-rated health were independently associated with both outcomes. Depression in the previous year was associated only with functional dependence in ADL.
Obstructive sleep apnea syndrome (Berlin Questionnaire) [ref 36]	Prevalence of 38.4%, associated with female gender, age of 60–79 years, living with a partner, having diabetes, pulmonary disease and stroke history.
Sedentary behavior (Measure of Older Adult's Sedentary Time) [ref 37]	Average sedentary behavior was 274.9 minutes/day. Age was inversely associated with sedentary behavior; income and education showed a direct relationship.
Tobacco smoking [ref 38]	13.2% of the older adults were smokers and 33.8% were former smokers. Male sex, the 60–69 year age range, black/brown skin color and single/separated were risk factors. Practicing the evangelical Christian religion was a protection factor.
Urinary incontinence [ref 39]	Prevalence of 15.9%. Adjusted analysis showed that risk increases with age over 75 years, female sex, regular, poor or very poor self-perceived health and presence of two or more morbidities.
Use of dental services in the previous 12 months [ref 40]	Prevalence of 13.9%. The probability of having an appointment was higher among women who partners, who had higher education level, belonged to the highest economic levels and who reported having some oral health problem. Older adults who reported being ex-smokers or smokers consulted less.

ADL, Activities of Daily Living. IADL, Lawton Instrumental Activities of Daily Living.

## Conclusion

This article shows that the EpiRural Cohort Study is providing knowledge about the health of older adults living in a rural community in southern Brazil. The main findings and methodological issues are also reported, as well as the strategies

adopted to overcome the challenges. The authors expect that the report will encourage researchers and health professionals to improve the knowledge about the health of rural older adults in developing countries.

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## REFERENCES:

- 1 Santosa A, Byass P. Diverse empirical evidence on epidemiological transition in low-and middle-income countries: population-based findings from INDEPTH network data. *PLoS One* 2016; **11(5)**: e0155753. DOI link, PMID:27187781
- 2 Government of Brazil. *Constitutional Amendment No. 95, of December 15, 2016. Change the Transitional Constitutional Provisions Act, to institute the New Tax Regime*. [In Portuguese]. Available: [web link](#) (Accessed 26 August 2020).
- 3 Menezes AP do R, Moretti B, dos Reis AAC. The future of the SUS: impacts of neoliberal reforms on public health – austerity versus universality. [In Portuguese]. *Saúde em Debate* 2020; **43(5)**: 58-70. DOI link
- 4 Brazilian Institute of Geography and Statistics (IBGE). *Cities and states of Brazil: Rio Grande do Sul/Rio Grande*. [In Portuguese]. Available: [web link](#) (Accessed 8 June 2020).
- 5 Brazilian Institute of Geography and Statistics (IBGE). *Demographic Census 2010: Characteristics of Population and Households – results of the universe: results*. [In Portuguese]. Available: [web link](#) (Accessed 27 July 2020).
- 6 Lima MHP. *The legal delimitation of urban spaces. Brazil: a geographical and environmental view at the beginning of the 21st century*. [In Portuguese]. Available: [web link](#) (Accessed 16 July 2021).
- 7 Saif-Ur-Rahman KM, Mamun R, Anwar I. Identifying gaps in primary healthcare policy and governance in low-income and middle-income countries: protocol for an evidence gap map. *BMJ Open* 2019; **9(2)**: e024316. DOI link, PMID:30819705
- 8 Bitton A, Ratcliffe HL, Veillard JH, Kress DH, Barkley S, Kimball M, et al. Primary health care as a foundation for strengthening health systems in low- and middle-income countries. *Journal of General Internal Medicine* 2017; **32(5)**: 566-571. DOI link, PMID:27943038
- 9 Ja Jadotte YT, Leisy HB, Noel K, Lane DS. The emerging identity of the preventive medicine specialty: a model for the population health transition. *American Journal of Preventive Medicine* 2019; **56(4)**: 614-621. DOI link, PMID:30782402
- 10 Katz S, Ford AB, Moskowitz RW, Jackson BA, Jaffe MW. Studies of illness in the aged. The Index of ADL: a standardized measure of biological and psychosocial function. *JAMA* 1963; **185**: 914-919. DOI link, PMID:14044222
- 11 Lawton MP, Brody EM. Assessment of older people: selfmaintaining and instrumental activities of daily living. *The Gerontologist* 1969; **9(3)**: 179-186. DOI link, PMID:5349366
- 12 Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. *Journal of General Internal Medicine* 2001; **16(9)**: 606-613. DOI link, PMID:11556941
- 13 Gardiner PA, Clark BK, Healy GN, Eakin EG, Winkler EA, Owen N. Measuring older adults' sedentary time: reliability, validity, and responsiveness. *Medicine and Science in Sports and Exercise* 2011; **43(11)**: 2127-2133. DOI link, PMID:21448077
- 14 Santos LP, Lindemann IL, Motta JVS, Mintem G, Bender E, Gigante DP. Proposal of a short-form version of the Brazilian Food Insecurity Scale. [In Portuguese]. *Revista de Saúde Pública* 2014; **48(5)**: 783-789. DOI link, PMID:25372169
- 15 Lebrão ML, Duarte YA de O, Santos JLF, da Silva NN. 10 Years of SABE Study: background, methodology and organization of the study. [In Portuguese]. *Revista Brasileira de Epidemiologia* 2018; **21(Suppl 2)**: e180002. DOI link, PMID:30726347
- 16 Slade GD. Derivation and validation of a shortform oral health impact profile. *Community Dentistry and Oral Epidemiology* 1997; **25**: 284-290. DOI link, PMID:9332805
- 17 Folstein MF, Folstein SE, McHugh PR. 'Mini-mental state'. A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research* 1975; **12(3)**: 189-198. DOI link
- 18 Saliba D, Elliott M, Rubenstein LZ, Solomon DH, Young RT, Kamberg CJ, et al. The Vulnerable Elders Survey: a tool for identifying vulnerable older people in the community. *Journal of the American Geriatrics Society* 2001; **49(12)**: 1691-1699. DOI link, PMID:11844005
- 19 Malmstrom TK, Morley JE. SARC-F: a simple questionnaire to rapidly diagnose sarcopenia. *Journal of the American Medical Directors Association* 2013; **14(8)**: 531-532. DOI link, PMID:23810110
- 20 Barbosa-Silva TG, Menezes AM, Bielemann RM, Malmstrom TK, Gonzalez MC; Grupo de Estudos em Composição Corporal e Nutrição (COCONUT). Enhancing SARC-F: Improving Sarcopenia Screening in the Clinical Practice. *Journal of the American Medical Directors Association* 2016; **17(12)**: 1136-1141. DOI link, PMID:27650212
- 21 Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap) – a metadata-driven methodology and workflow process for providing translational research informatics support. *Journal of Biomedical Informatics* 2009; **42(2)**: 377-381. DOI link, PMID:18929686
- 22 Lohman T, Roche A, Martorell R. *Anthropometric standardization reference manual*. Champaign: Human Kinetics Books, 1988.
- 23 Habicht JP. Standardization of quantitative epidemiological methods in the field. [In Portuguese]. *Boletín de la Oficina Sanitaria Panamericana* 1974; **76**: 375-384.
- 24 World Health Organization. *International statistical classification of diseases and related health problems: ICD-10 tenth revision*. [In Portuguese]. 3rd ed. São Paulo: EDUSP, 1996.
- 25 Thumé E, Kessler M, Machado KP, Nunes BP, Volz PM, Wachs LS, et al. Cohort study of ageing from Bagé (SIGa-Bagé), Brazil:

- profile and methodology. *BMC Public Health* 2021; **21(1)**: 1089. DOI link, PMID:34098933
- 26** Lima-Costa MF, de Andrade FB, de Souza PRB Jr, Neri AL, Duarte YAO, Castro-Costa E, et al. The Brazilian Longitudinal Study of Aging (ELSI-Brazil): Objectives and Design. *American Journal of Epidemiology* 2018; **187(7)**: 1345-1353. DOI link, PMID:29394304
- 27** Boing AC, Peres KG, Boing AF, Hallal PC, Silva NNN, Peres MA. EpiFloripa Health Survey: the methodological and operational aspects behind the scenes. [In Portuguese]. *Revista Brasileira de Epidemiologia* 2014; **17(1)**: 147-162. DOI link, PMID:24896789
- 28** Koch E, Bravo M, Romero C, Díaz A, Castañeda H, Aguilera H, et al. Height, an early life predictor of cardiovascular risk factors and mortality in Chilean adults: The San Francisco Project Cohort Study. [In Portuguese]. *Revista Chilena de Cardiologia* 2011; **30(3)**: 198-206. DOI link
- 29** Arroyo AM, Aguilar CC, Molina XP, Sanchez XC, Fisberg RM. Dietary patterns of adolescents from the Chilean Growth and Obesity Cohort Study indicate poor dietary quality. *Nutrients* 2020; **12(7)**: 2083. DOI link, PMID:32674402
- 30** National Bureau of Statistics of China. *National data*. 2018. Available: [web link](#) (Accessed 16 August 2021).
- 31** Liu X, Mao Z, Li Y, Wu W, Zhang X, Huo W, et al. Cohort profile: the Henan rural cohort: a prospective study of chronic non-communicable diseases. *International Journal of Epidemiology* 2019; **48(6)**: 1756-1756j. DOI link, PMID:30915440
- 32** Zhang M, Zhao Y, Sun L, Xi Y, Zhang W, Lu J, et al. Cohort profile: the Rural Chinese Cohort Study. *International Journal of Epidemiology* 2020; **50(3)**: 723-724i. DOI link, PMID:33367613
- 33** Ferreira LS, Moreira LR, Paludo SS, Meucci RD. Access to primary health care by older adults from rural areas in Southern Brazil. [In Portuguese]. *Revista de Saúde Pública* 2020; **54**: 1-11. DOI link, PMID:33331492
- 34** Corrêa ML, Carpena MX, Meucci RD, Neiva-Silva L. Depression in the elderly of a rural region in Southern Brazil. [In Portuguese]. *Ciência & Saúde Coletiva* 2020; **25(6)**: 2083-2092. DOI link, PMID:32520256
- 35** Meucci RD, Runzer-Colmenares FM, Parodi JF, de Mola CL. Falls among the elderly in Peruvian Andean communities and the rural far south of Brazil: prevalence and associated factors. *Journal of Community Health* 2020; **45(2)**: 363-369. DOI link, PMID:31559518
- 36** Mass NM, Mendoza-Sassi RA, Meucci RD, Cesar JA. Food insecurity in rural families in the extreme south of Brazil. [In Portuguese]. *Ciência & Saúde Coletiva* 2020; **25(7)**: 2605-2614. DOI link, PMID:32667544
- 37** Meucci RD, Aguiar de Oliveira ASL, Araújo GC, Gonzalez TN, Pagliaro G, Hoffmann T, et al. Functional dependence among older adults: a cross-sectional study with a rural population of southern Brazil. *Rural and Remote Health* 2020; **20(4)**: 5985. DOI link, PMID:33002364
- 38** Perceval AH, Meucci RD. High-risk prevalence for obstructive sleep apnea syndrome in elderly population resident in the rural area of Rio Grande-RS. [In Portuguese]. *Cadernos Saúde Coletiva* 2020; **28(2)**: 241-250. DOI link
- 39** Leão OAA, Knuth AG, Meucci RD. Sedentary behavior in elderly residents from the rural area in Southern Brazil. [In Portuguese]. *Revista Brasileira de Epidemiologia* 2020; **23**: E200008. DOI link, PMID:32130397
- 40** Silva PAD, Meucci RD, Luzini R, Paiva LA. Tobacco smoking prevalence and associated factors among the elderly in the rural area of Rio Grande/RS, Brazil. *Rural and Remote Health* 2019; **19(4)**: 4982. DOI link, PMID:31752496
- 41** Dziekaniak AC, Meucci RD, Cesar JÁ. Urinary incontinence among older adults living in the rural area of a municipality in southern Brazil. [In Portuguese]. *Geriatrics, Gerontology and Aging* 2019; **13(1)**: 4-10. DOI link
- 42** Schroeder FMM, Mendoza-Sassi RA, Meucci RD. Oral health condition and the use of dental services among the older adults living in the rural area in the south of Brazil. [In Portuguese]. *Ciência & Saúde* 2020; **25(6)**: 2093-2102. DOI link, PMID:32520257