

The comorbidity of diabetes-depression and its association with disability amongst elderly prison inmates

Sergio Bravo-Cucci¹, Gloria Cruz-Gonzales², Regina Medina-Espinoza¹,
Ada Paca-Palao³

¹School of Rehabilitation Therapies. Faculty of Medical Technology. Federico Villarreal National University. Lima. Peru.

²School of Clinical Laboratory Practice and Pathological Anatomy. Faculty of Medical Technology. Federico Villarreal National University. Lima. Peru.

³Faculty of Health Sciences. Technological University of Peru. Lima. Peru.

ABSTRACT

Objectives: The objective of the study was to verify the strength of association of depression as a comorbidity of diabetes with the presence of six types of disability in the elderly in prison.

Material and method: Cross-sectional association study based on a secondary analysis of the 2016 Peru National Penitentiary Census. The population were older adults, who were held in prisons in Peru. Inmates 60 years of age or older, and both sexes were included. The response variables were the six types of permanent disability. The exposure variables were the self-report of diabetes, depression and the comorbidity of depression with diabetes diagnosed by a health professional. The sample was constituted by 2. 658 older adults.

Results: There was an increase in the probability of presenting the six disabilities analyzed due to the presence of comorbid diabetes with depression ($p < 0.05$). The measure of greatest strength of association is for the disability to relate OR(a) 10.23, followed by the disability to move OR(a) 6.12 and the lowest strength of association found was for the hearing impairment OR(a) 2.80.

Discussion: A significant increase was found in the probability of presenting the six disabilities analyzed due to the presence of comorbid diabetes with depression compared to suffering from only one of these conditions or not suffering from them.

Key words: depression, diabetes mellitus, aging, prisons.

Text received: 18/02/2020

Text accepted: 08/02/2022

INTRODUCTION

According to estimates by the United Nations Office on Drugs and Crime (UNODC), there were approximately 11.7 million people imprisoned worldwide in 2019, an increase of 21% since 2000 (9.3 million)¹. According to the National Prisons Census of Peru, there are currently 76,180 inmates distributed in 66 prisons, of whom 3,001 (4%) are over 60 years of age². The morbidity profile of this population is characterised by a range of diseases,

the most prevalent being depression, anxiety, chronic lung disease, high blood pressure and diabetes².

Diabetes is regarded as a non-communicable disease that has a major impact on global health³, and therefore efforts are being made to reduce its incidence and impact⁴. According to the World Health Organisation (WHO), diabetes was the direct cause of death for 1.5 million people 2019⁵, and the incidence worldwide is increasing⁶. The disease has more of an impact on the elderly and is a risk factor for heart diseases and death⁷.

According to the Peruvian Family Health and Demographics Survey of 2020, diabetes is more common amongst the elderly (11%) than in other population groups⁸, which is the reason for the higher risk of mortality. There are studies that indicate that the most common co-morbidities in diabetes are high blood pressure and depression^{9,10}.

It has also been reported that there is a two-way association between diabetes and depression, in other words, one can lead to the other^{9,11,12}. Some studies indicate that depression presents twice as often amongst diabetics as it does in persons who do not have the disease¹³. They also state that both diabetes and depression can lead to disabilities in the elderly¹⁴⁻¹⁷ that can have a negative impact on their quality of life and even restrict their participation in daily activities.

Persons with disabilities are those with physical, mental, intellectual or sensory deficiencies¹⁸ that in the long term can restrict their activities and participation, as a result of the health conditions and the contextual factors that surround the process¹⁸. The prevalence of disability amongst the elderly has increased as a result of demographic transition and an increased prevalence of chronic diseases¹⁸.

According to the WHO World Report on Disability in 2011, the prevalence of disabilities worldwide is 38%¹⁹. In the case of Peru, the 2012 Report on Disabled Persons by the National Institute of Statistics and Information Technology states that the population of 60 to 69 years of age has a 20% prevalence of disability, while this figure increases to 24% amongst the 70 to 79 age group²⁰.

As we mentioned, some studies have indicated that there is a risk of suffering from a disability as a result of the depression-diabetes co-morbidity^{14-16,21}, but they have not been carried out with the six disabilities of a prison population in mind²². In this regard, any study that considers this issue would be particularly relevant given the major demographic and epidemiological transition. It is therefore necessary to establish healthcare policies for the elderly, especially for those living in overcrowded conditions in prisons, where there are many limitations on health services, which are meagre, do not cover all the medical specialities and do not offer the necessary medical treatment.

The aim of this study is to establish the strength of the association of the depression-diabetes co-morbidity with the presence of six types of disability amongst elderly prison inmates. The hypothesis that we seek to corroborate is whether elderly inmates with a depression-diabetes co-morbidity present a

higher likelihood of suffering from a disability than elderly inmates without said co-morbidity.

MATERIAL AND METHOD

Design

An analysis of the 2016 Peruvian National Prisons Census was used as the basis for a cross-sectional study. The population was made up of elderly prison inmates in the 66 penitentiary centres managed by the Peruvian National Prisons Institute.

The census participants consisted of inmates of both sexes of 60 years of age and over, who reported that they had (or did not have) diabetes or depression diagnosed by a health professional. Inmates who reported that they had diabetes or depression but were not diagnosed by a health professional were excluded.

The sample was made up of a census, consisting of 2,658 adults who met the criteria mentioned above.

Variables

Result variable

Disability, which was categorised into six sub-domains, taking into consideration the recommendations of the Washington group on disability²². It was categorised into: 1) reduced mobility; 2) visual disability; 3) hearing disability; 4) speaking disability; 5) difficulties in relating to others; and 6) difficulties in understanding.

Exposure variable

Built from the health-related questions and categorised into: 1) depression-diabetes co-morbidity; 2) diabetes only; 3) depression only; 4) absence of diabetes and depression.

Confounding variables

These variables are: 1) sex (female and male); 2) age (categorised into three groups: 60-69 years, 70-79 years and 80-89 years); 3) physical exercise (0=no and 1=yes); and 4) drug consumption before imprisonment (0=no and 1=yes).

Instruments

The national prison census certificate was used as an instrument for gathering data. As regards the outcome variable, information was gathered about disability in line with the recommendations of the Washington group, specifying six categories in this

area al²². The same classification was used in Peru in the 12th National Population Census of 2017²³.

The following text was prepared, which included a set of questions: "Now I am going to ask you some questions to see if you have some kind of permanent problem that stops you or impedes you from doing your daily activities. "Do you have any permanent problems with moving around, walking or using your arms and legs? ¿Seeing, do you use glasses? Taking or communicating, do you use sign language or another method? Hearing, do you use a hearing aid? Understanding or learning (concentrating and remembering)? Relating to others because of your thoughts, feelings, emotions or behaviour?"

For the variables of suffering from diabetes and depression, the census certificate offers a two-level consultation, first it asks if the person suffers from these conditions, and if the answer is yes, there is a second question about whether the person has been diagnosed by a health professional, The questions for diabetes take the following form: "Do you suffer from diabetes, or rather, from high levels of blood sugar?", with the following question: "Were you diagnosed by a health professional?". The questions for depression have a similar format: "Do you suffer from depression?", and then: "Were you diagnosed by a health professional?" In this regard, the reports of depression and diabetes made by the person surveyed were documented as valid²⁴⁻²⁷.

As regards the confounding variables, the following questions were used: gender, if the interviewee had participated in a sports activity in the previous beforehand and if they consumed drugs before entering prison. The last question could be under-reported²⁸, but it was included for integration as a potential confounder.

Procedures

The procedures for obtaining the information as a primary source can be seen in the census technical document²⁹. The following processes were followed for the study: the data bases were obtained from the website of the Peruvian National Institute of Statistics and Information Technology (available at: <http://ineiinei.gob.pe/microdatos/>), the files were merged and the variables were re-codified for later analysis.

Statistical analysis

The Stata 14 (Stata Corp, Texas, USA) statistical program was used for the statistical analysis. Measurements of absolute frequency and percentages were used for the descriptive analysis. Associations were

looked for in the bivariate analysis and potential confounders were identified with the chi-squared test or Fisher's exact test. After testing the scenarios required for multivariate analysis, logistical regression techniques were applied to calculate the crude and adjusted odds ratios; the adjustment variables were statistical and only those that were found to be associated with the specific disability were integrated into the model.

Secondary epidemiological analyses were carried out with the Openepi program, where the population aetiological fraction was calculated along with the aetiological fraction in exposed subjects.

Ethical considerations

The study made use of a secondary base available at the National Institute of Statistics and Information Technology website for unrestricted use in research, and so express permission was not required for downloading or processing.

The research project followed international parameters regarding bioethical practices in research, and complied with the Helsinki II Declaration and Peruvian regulations on research.

Prison inmates are regarded as a vulnerable population, and so a review of the literature was carried out, which showed that there were no complaints or reports about breaches of bioethics in preparing the census. The database is anonymous and does not allow the inmates to be identified.

RESULTS

Characteristics of the population

The population studied was made up of 2,658 adults of over 60 years age or more who complied with the inclusion criteria. The frequency and percentage of the socio-demographic variables of health and disability can be seen in Table 1.

Factors associated with disability

A bivariate analysis was carried out on each socio-demographic variable (sex, age, sports activity, drug consumption before entering prison) and on health (co-morbidity) with each of the six types of disability (visual, hearing, understanding, mobility, relationships and speech). The chi-squared or Fisher's exact test were used to carry out the associations.

A significant association in the socio-demographic co-variables was found for sex and the self-reported disability in understanding ($p=0.047$) and mobility ($p=0.001$), while no other associations were

found with the other disabilities. A general association was found in the age groups where the older the group was, the greater the disability in hearing ($p < 0.001$), understanding ($p = 0.01$) and mobility ($p < 0.001$). Associations were found between sports activities and the visual ($p = 0.004$), hearing ($p < 0.001$), speaking ($p = 0.024$) and mobility ($p < 0.001$) disabilities. In the case of drug consumption before entering prison, no associations with any of the six types of disability were found (Tables 2 and 3).

As regards the variable of interest, the depression-diabetes co-morbidity was associated with the six disabilities ($p \leq 0.001$), with a greater prevalence of

disability in the group that presented the co-morbidities (Tables 2 and 3).

Strength of association of presenting disability in relation to co-morbidity

The magnitude or strength of association of presenting more or less probability of suffering from a disability, according to whether the subject is exposed solely to depression, to diabetes or with a depression-diabetes co-morbidity, or is not exposed to any event, was determined by calculating the crude and adjusted odds ratio of the socio-demographic variables

Table 1. Characteristics of prison population sample of adults over 60 years of age (Peru 2016).

Characteristics		N = 2.658		
		n	%	
Socio-demographic	Sex	Female	137	5.2
		Male	2.521	94.9
	Age group (years)	60-69	2.147	80.8
		70-79	459	17.3
		80-89	52	2.0
	Physical activity (n = 2.643)	Yes	932	36.3
No		1.711	64.7	
Drug consumption (n = 2.648)	Yes	205	7.7	
	No	2.443	92.3	
Health	Depression	Yes	222	8.4
		No	2.436	91.7
	Diabetes	Yes	299	11.3
		No	2.359	88.8
	Comorbidity	No depression or diabetes	2.176	81.9
		Diabetes only	260	9.8
		Depression only	183	6.9
		Diabetes with depression	139	1.5
Disability	Mobility disability	Sí	752	28.3
		No	1.906	71.7
	Speech disability	Sí	83	3.1
		No	2.575	96.9
	Visual disability	Sí	1.084	40.8
		No	1.574	59.2
	Hearing disability	Sí	488	81.6
		No	2.170	18.4
	Difficulties in understanding	Sí	322	12.1
		No	2.336	87.9
	Difficulties in relating to others	Sí	92	3.5
		No	2.566	96.5

that presented a significant association with disability (Tables 2 and 3).

Exposure solely to depression in the multivariate logistical regression models increases the likelihood of suffering from the following disabilities: understanding, with an adjusted OR of 2.37 ($p<0.001$); visual, with an adjusted OR of 2.01 ($p<0.001$); hearing, with an adjusted OR of 1.95 ($p<0.001$); mobility, with an adjusted OR of 2.70 ($p<0.001$), along with relationship difficulties, but only in the crude model, with a crude OR of 3.04 ($p<0.001$).

As regards diabetes, strong significant associations were found in visual disabilities, with an adjusted OR of 1.41 ($p=0.01$); hearing disabilities, with an adjusted OR of 1.45 ($p=0.022$); and mobility difficulties, with an adjusted OR of 1.98 ($p<0.001$) (Tables 4 and 5).

In the case of depression-diabetes co-morbidity, there was an increased likelihood of suffering from speech disabilities, with an adjusted OR of 3.98

($p=0.012$); from understanding difficulties, with an adjusted OR of 2.97 ($p=0.003$); visual disabilities, with an adjusted OR of 4.09 ($p<0.001$); hearing difficulties, with an adjusted OR of 2.8 ($p=0.003$); mobility issues, with an adjusted OR of 5.87 ($p<0.001$); and relationship difficulties, with a crude OR of 10.23 ($p<0.001$) (Tables 4 and 5).

Secondary epidemiological calculations

The secondary calculations consisted of determining the crude prevalence ratio, which indicates the ratio between the prevalence of the result (disability), if there is diabetes with depression as a denominator, and the prevalence of the result (disability) if there is no diabetes or depression.

The adjusted OR previously calculated in Tables 4 and 5 indicates the chance of presenting the result (disability) as a numerator if there is exposure to diabetes with depression and as a denominator when

Table 2. Factors associated with disabilities in speaking, understanding and sight in prison population of adults over 60 years of age (Peru 2016).

Characteristics	Speech disability					Understanding disability					Visual disability					
	n	%	n	%	P	n	%	n	%	P	n	%	n	%	P	
Socio-demographic																
Sex	Female	6	4.4	131	95.6	0.320*	24	17.5	113	82.5	0.047	64	46.5	73	53.3	0.147
	Male	77	3.1	2.444	96.9		298	11.8	2.223	88.2		1020	40.7	1.501	59.5	
Age group (years)	60-69	65	3	2082	97	0.662	240	11.2	1.907	88.8	0.010	865	40.3	1.282	59.7	0.077
	70-79	17	3.7	442	96.3		73	15.9	386	84.1		190	41.4	269	58.6	
	80-89	1	1.9	51	98.1		9	17.3	43	82.7		29	55.8	23	44.2	
Physical activity (n=2.643)	Yes	19	2	913	98	0.024	102	10.9	830	89.1	0.163	586	62.9	346	37.1	0.004
	No	62	3.6	1.649	96.4		219	12.8	1.492	87.2		978	57.2	733	42.8	
Drug consumption (n = 2.648)	Yes	5	2.4	200	97.6	0.571	23	11.2	182	88.8	0.680	80	39	125	70	0.578
	No	77	3.2	2.366	96.8		298	12.2	2.415	87.8		1002	41	1.441	59	
Health																
Comorbidity	No depression or diabetes	62	2.9	2.114	97.1	0.001	239	11	1.937	89	<0.001	833	38.3	1.343	61.7	<0.001
	Diabetes only	9	3.5	251	69.5		29	11.2	231	88.9		122	46.9	138	53.1	
	Depression only	8	4.4	175	95.6		43	23.5	140	76.5		101	55.19	82	44.8	
	Diabetes with depression	4	10.3	35	89.7		11	28.2	28	71.8		28	71.8	11	28.2	

Note. P values obtained from chi square test, with the exception of the value marked with an asterisk (*), obtained from Fisher's exact test.

Table 3. Factors associated with disabilities in moving, relating to others and speaking in prison population of adults over 60 years of age (Peru 2016).

Characteristics	Mobility disability					Relationship disability					Hearing disability					
	Yes		No		P	Yes		No		P	Yes		No		P	
	n	%	n	%		n	%	n	%		n	%	n	%		
Socio-demographic																
Sex	Female	56	40.9	81	59.1	0.001	4	3.5	133	97.1	0.722*	17	12.4	120	87.6	0.065
	Male	696	27.6	1.826	72.4		88	2.9	2433	96.5		471	18.7	2.050	81.3	
Age group (years)	60-69	570	26.6	1.577	73.5	<0.001	69	3.2	2078	96.8	0.202	349	16.3	1.798	83.7	<0.001
	70-79	161	35.1	298	64.9		22	4.8	437	95.2		122	26.6	337	73.4	
	80-89	21	40.4	31	59.6		1	1.9	51	98.1		17	32.7	35	67.3	
Physical activity (n=2.643)	Yes	194	20.8	738	79.2	<0.001	32	3.4	900	96.6	0.889	125	13.4	807	86.59	<0.001
	No	555	32.4	1.156	67.6		57	3.3	1654	96.7		360	21	1.351	79	
Drug consumption (n = 2.648)	Yes	70	34.2	135	65.9	0.051	6	2.9	199	97.1	0.656	37	18.1	168	81.9	0.895
	No	678	27.8	1.765	72.2		86	3.5	2357	96.5		450	18.4	1.993	81.6	
Health																
Comorbidity	No depression or diabetes	536	24.6	1.640	75.4	<0.001	62	2.9	2114	97.2	<0.001	363	16.7	1.813	83.3	<0.001
	Diabetes only	104	40	156	60		6	2.3	254	97.7		59	22.7	201	77.3	
	Depression only	86	47	97	53		15	8.2	168	91.8		52	28.4	131	71.6	
	Diabetes with depression	26	66.7	13	33.3		9	23	30	76.9		14	35.9	25	64.1	

Note. P values obtained from chi square test, with the exception of the value marked with an asterisk (*), obtained from Fisher's exact test.

there is the likelihood of presenting disability when there is no depression or diabetes (not exposed). The aetiological fraction of the population as the contribution percentage in a given disability, where diabetes with depression is presented and the aetiological fraction of exposed subjects explain the reduction of the disability in percentages, in cases where the exposed subjects stop being so (Table 6).

DISCUSSION

This study, carried out with data from the 2016 Peruvian National Prisons Census, found associations between the depression-diabetes co-morbidity and the six disabilities (hearing, visual, understanding, mobility, relationships and speech) established by the Washington group for disability. In other words, the hypothesis is accepted that elderly prison

inmates with depression-diabetes co-morbidity are more likely to have a disability estimated at: 71.8% sight; 66.7% mobility; 23.0% relating to others; 35.9% hearing; 28.2% understanding; and 10.3% speech, in comparison to elderly inmates without co-morbidities. This relationship was also visible in the associations between disability and only diabetes or depression, but at lower proportions than when there was a co-morbidity.

There are a number of factors that may play a part in the co-morbidity. The direction The direction can be two-way: persons with diabetes may be more likely to get depressed and depressed persons may be more at risk of suffering from diabetes^{11,16,30}.

On the other hand, co-morbidity increases the probability of multiple disabilities, which can be seen in the results of this study. Although this has not been seen in similar studies on elderly prison inmates, the results do match those in a research project carried

out in Singapore¹⁶, where a 15 year long longitudinal monitoring study on a Hispanic population in the

USA showed that depression accelerated the disability process over time¹⁴.

Table 4. Crude and adjusted odds ratio for disabilities in speaking, understanding and sight according to associated factors in the prison population of adults over 60 years of age (Peru 2016).

	Speech disability*				Understanding disability*				Visual disability*			
	crude OR	CI95	adjusted OR	CI95	crude OR	CI95	adjusted OR	CI95	crude OR	CI95	adjusted OR	CI95
Comorbidity												
No depression or diabetes	1	Ref.	1	Ref.	1	Ref.	1	Ref.	1	Ref.	1	Ref.
Diabetes only	1.22	0.60 to 2.49	1.23	0.60 to 2.51	1.02	0.68 to 1.153	1.01	0.67 to 1.52	1.43	1.10 to 1.85	1.41	1.09 to 1.83
	p = 0.580		p = 0.574		p = 0.934		p = 0.966		p = 0.007‡		p = 0.010‡	
Depression only	1.56	0.73 to 3.31	1.64	0.77 to 3.48	2.49	1.72 to 3.59	2.37	1.64 to 3.43	1.99	1.47 to 2.69	2.01	1.48 to 2.72
	p = 0.248		p = 0.201		p <0.001‡		p <0.001‡		p <0.001‡		p <0.001‡	
Diabetes with depression	3.90	1.34 to 11.30	3.98	1.37 to 11.58	3.18	1.56 to 6.48	2.97	1.45 to 6.11	4.10	2.03 to 8.29	4.09	2.03 to 8.27
	p = 0.012‡		p = 0.011‡		p = 0.001‡		p = 0.003‡		p <0.001‡		p <0.001‡	

Note. *adjusted OR: OR adjusted to physical activity. †adjusted OR: OR adjusted to sex and age. ‡P significant value ≤0,05. CI95: confidence interval of 95%; OR: *odds ratio*; adjusted OR: adjusted odds ratio (obtained from logistic regression); crude OR: *odds ratio* crude; Ref: Reference.

Table 5. *Odds ratio* crudo y ajustado de la discapacidad para moverse, relacionarse y oír según los factores asociados en la población penitenciaria de adultos mayores de 60 años (Perú 2016).

	Mobility disability*				Relationship disability*				Hearing disability*			
	crude OR	CI95	adjusted OR	CI95	crude OR	CI95	adjusted OR	CI95	crude OR	CI95	adjusted OR	CI95
Comorbid diabetes												
No depression or diabetes	1	Ref.	1	Ref.	1	Ref.	1	Ref.	1	Ref.	1	Ref.
Diabetes only	2.04	1.56 to 2.66	1.98	1.51 to 2.60	0.81	0.34 to 1.88	NA	NA	1.47	1.07 to 2.00	1.45	1.05 to 1.99
	p <0.001‡		p <0.001‡		p = 0.617				p = 0.016‡		p = 0.022‡	
Depression only	2.71	2.00 to 3.68	2.70	1.98 to 3.69	3.04	1.70 to 5.47	NA	NA	1.98	1.41 to 2.79	1.95	1.38 to 2.76
	p <0.001‡		p <0.001‡		p <0.001‡				p <0.001‡		p <0.001‡	
Diabetes with depression	6.12	3.12 to 11.99	5.87	2.96 to 11.63	10.23	4.66 to 22.46	NA	NA	2.80	1.44 to 5.43	2.80	1.43 to 5.48
	p <0.001‡		p <0.001‡		p <0.001‡				p = 0.002‡		p = 0.003‡	

Note. * †adjusted OR: ajustado a sexo, grupo etario y actividad física deportiva. †adjusted OR: ajustado a grupo etario y actividad física deportiva. ‡p valor significativo ≤0,05. CI95: intervalo de confianza del 95%; NA: adjusted OR calculation not applicable due to there being no potential statistical confounding variables in the bivariate analysis; OR: *odds ratio* (razón de posibilidades); adjusted OR: adjusted odds ratio (obtained from logistic regression); OR(c): *odds ratio* crudo; Ref: Reference.

Table 6. Secondary epidemiological calculations, prevalence ratio and aetiological fraction of presenting disability according to exposure to diabetes with depression.

Result	Exposure	crude PR	adjusted OR	AFp OR		AFe OR	
				(AFp OR)	CI95	(AFe OR)	CI95
Difficulties in relating to others	Diabetes with depression	7.9	10.23*	11.4%	4.4 to 22.0	90.2%	78.5 to 95.6
Mobility disability		2.71	6.12	3.9	2.1 to 5.7	83.7%	68 to 91.7
Speech disability		3.60	3.98	4.5	1.4 to 10.4	74.3%	25.6 to 91.2
Visual disability		1.87	4.09	2.46%	1.2 to 3.7	75.6%	50.8 to 87.9
Difficulties in understanding		2.56	3.18	3.0%	0.4 to 5.6	68.6	36.1 to 84.6
Hearing disability		2.1	2.80	2.4%	0.4 to 4.4	64.3%	30.6 to 81.6

Note. *crude OR.

AFe|OR: aetiological fraction in exposed subjects; AFp|OR: aetiological fraction in population; CI95: confidence interval of 95%; OR: *odds ratio*; adjusted OR: adjusted odds ratio; crude PR: crude prevalence ratio.

Calculations made using not having depression or diabetes as a reference.

Depression affects the capacity to relate to others, and this can explain the disability in relating to others and in mobility^{10,11}. The effect on the disability in mobility, vision and hearing, may be explained by the deterioration provoked by diabetes³¹⁻³³, while the disability in speech and understanding are related to the cognitive deterioration common to both conditions^{34,35}. These results match the ones obtained in this study.

Furthermore, the factors that may explain the differences in the association are related to the socio-demographic characteristics of older adults. This study showed that physical and sports activities are an important factor in visual, hearing (besides age), mobility and speech disabilities, while sex and age are relevant factors in mobility disabilities. These results match those from a longitudinal study carried out in China, which showed that the association of depression and disability are different according to gender, and so should be treated differently^{17,36}. Only in the case of understanding disabilities was there an association with sex and the age group.

The multivariable models adjusted by the variables of physical activity, sex and age group, maintained the probability of having the six types of disability in older adults with depression-disability co-morbidity in comparison to those who do not have both co-morbidities.

There are studies that show other relevant factors, such as differentiated health services and socio-emotional support, which can mitigate this strength of association. This was shown in a Canadian study on adults with depression-diabetes co-morbidity, the results of which showed greater functional disability, while indicating that this process can be mitigated with social support¹⁵.

This evidence highlights the need to strengthen and amplify the national prison census, in order to gather information that can help to more effectively define the interventions, strategies and guidelines for promotion, prevention and care for the prison population, especially elderly inmates, given that the health services are limited and not all the medical specialisations are available.

One of the main limitations of this study is the design, which does not permit the direction of the variables to be clearly established. However, the estimates match other studies that show that disability is greater amongst women, the elderly and when both co-morbidities are present. A selection bias was identified in depression diagnosed by a health professional, therefore there may be a high level of under-reporting, but the base of the census presented enough power for analysis of this variable.

There may also be a memory bias, although a reduced one, given that the questions about the main variables refer to the present time (diabetes, depression, disability, sex, age) or an event that took place no more than a month ago (participation in sports activities over the last month). The question about drug use before entering prison may have a greater memory bias, since it depends on the time each participant has spent in prison. It may also be subject to under-reporting²⁸.

The strengths of this study include its representative nature at national level and the opportunity to present estimates with different strengths of association for each co-morbidity, which enables disability to be better understood, helps in making timely decisions and prioritising the services that should be implemented in prisons.

CONCLUSIONS

The main finding of this study is that the hypothesis about the increased likelihood of presenting the six disabilities due to the presence of co-morbid diabetes and depression ($p < 0.001$) has been confirmed.

The most powerful measurement of association is in the disability in relating to others, with an adjusted OR of 6.99; followed by mobility disabilities, with an adjusted OR of 5.52, while the lowest strength of association found was for hearing disabilities, with an adjusted OR of 1.75.

The largest aetiological fraction in the population (with co-morbid diabetes and without diabetes or depression) was in the disability in relating to others, where the modification of the exposure (co-morbid) diminished by 16%. The largest fraction of exposed subjects also corresponds to the disability in relating to others, where 86% of this disability can be attributed to exposure.

These findings may be used for establishing approaches for management of depression-diabetes in prison, so as to reduce their impact on the disability load. In terms of research, primary studies that set out to clarify other variables not included in this study are recommended, such as the characteristics of these diseases, medical management, nutritional and psychological treatment and treatment adherence as factors associated with disability in older adults.

CORRESPONDENCE

Sergio Bravo-Cucci
E-mail: prof.sbravo@gmail.com

REFERENCES

1. Oficina de las Naciones Unidas contra la Droga y el Delito. Casi doce millones de personas privadas de la libertad a nivel mundial. [Internet]. UNODC; 2021. [Citado 20 Ene 2022]. Disponible en: https://www.unodc.org/documents/data-and-analysis/statistics/Data_Matters_1_prison_spanish.pdf
2. Instituto Nacional de Estadística e Informática. Perú: Primer Censo Nacional Penitenciario 2016. [Internet]. Lima: INEI; 2016. [Citado 20 Ene 2022]. Disponible en: https://www.inei.gob.pe/media/MenuRecursivo/publicaciones_digitales/Est/Lib1364/libro.pdf
3. Bennett JE, Stevens GA, Mathers CD, Bonita R, Rehm J, Kruk ME, et al. NCD Countdown 2030: worldwide trends in non-communicable disease mortality and progress towards Sustainable Development Goal target 3.4. *Lancet*. 2018;392(10152):1072-88.
4. Kontis V, Mathers CD, Bonita R, Stevens GA, Rehm J, Shield KD, et al. Regional contributions of six preventable risk factors to achieving the 25 × 25 non-communicable disease mortality reduction target: A modelling study. *Lancet Glob Health*. 2015;3(12):e746-57.
5. Organización Mundial de la Salud. Diabetes. [Internet]. En: Notas descriptivas. OMS; 10 Nov 2021. [Citado 20 Ene 2022]. Disponible en: <https://www.who.int/es/news-room/fact-sheets/detail/diabetes>
6. Sircar M, Bhatia A, Munshi M. Review of Hypoglycemia in the Older Adult: Clinical Implications and Management. *Can J Diabetes*. 2016;40(1):66-72.
7. Balakumar P, Maung-U K, Jagadeesh G. Prevalence and prevention of cardiovascular disease and diabetes mellitus. *Pharmacol Res*. 2016;113(Pt A):600-9.
8. Instituto Nacional de Estadística e Informática. Perú: Enfermedades no transmisibles y transmisibles, 2020 [Internet]. Lima; INEI; 2021. [Citado 20 Ene 2022]. Disponible en: https://proyectos.inei.gob.pe/endes/2020/SALUD/ENFERMEDADES_ENDES_2020.pdf
9. Chima CC, Salemi JL, Wang M, Mejía de Grubb MC, González SJ, Zoorob RJ. Multimorbidity is associated with increased rates of depression in patients hospitalized with diabetes mellitus in the United States. *J Diabetes Complications*. 2017;31(11):1571-9.
10. Bădescu S V, Tătaru C, Kobylinska L, Georgescu EL, Zahiu DM, Zăgrean AM, et al. The association between Diabetes mellitus and Depression. *J Med Life*. 2016;9(2):120-5.
11. Kabue S, Liu V, Dyer W, Raebel M, Nichols G, Schmittiel J. Identifying Common Predictors of Multiple Adverse Outcomes among Elderly Adults with Type-2 Diabetes. *Med Care*. 2019;57(9):702-9.
12. Razzak HA, Harbi A, Ahli S. Depression: Prevalence and associated risk factors in the United Arab Emirates. *Oman Med J*. 2019;34(4):274-82.
13. Pan A, Lucas M, Sun Q, Van Dam RM, Franco OH, Manson JAE, et al. Bidirectional association between depression and type 2 diabetes mellitus in women. *Arch Intern Med*. 2010;170(21):1884-91.
14. Salinas JJ, González JMR, Al Snih S. Type 2 diabetes, depressive symptoms and disability over a 15-year follow-up period in older Mexican Ame-

- ricans living in the southwestern United States. *J Diabetes Complications*. 2018;32(1):75-82.
15. Levy M, Burns RJ, Deschênes SS, Schmitz N. Does Social Support Moderate the Association Among Major Depression, Generalized Anxiety Disorder, and Functional Disability in Adults With Diabetes? *Psychosomatics*. 2017;58(4):364-74.
 16. Subramaniam M, Abdin E, Vaingankar JA, Picco L, Seow E, Chua BY, et al. Comorbid diabetes and depression among older adults – prevalence, correlates, disability and healthcare utilisation. *Ann Acad Med Singap*. 2017;46(3):91-101.
 17. Kong D, Solomon P, Dong XQ. Depressive Symptoms and Onset of Functional Disability Over 2 Years: A Prospective Cohort Study. *J Am Geriatr Soc*. 2019;67(S3):S538-44.
 18. Organización Mundial de la Salud. Discapacidad y salud. En: *Notas descriptivas* [Internet]. OMS; 24 Nov 20221. [Citado 20 Ene 2022]. Disponible en: <http://www.who.int/mediacentre/factsheets/fs352/es/>
 19. Organización Mundial de la Salud. Informe mundial sobre la discapacidad. [Internet]. OMS; 2011. [Citado 20 Ene 2022]. Disponible en: https://www.who.int/disabilities/world_report/2011/summary_es.pdf
 20. Instituto Nacional de Estadística e Informática. Perú: Características de la Población con Discapacidad. [Internet]. INEI; 2015. [Citado 20 Ene 2022]. Disponible en: https://www.inei.gob.pe/media/MenuRecursivo/publicaciones_digitales/Est/Lib1209/Libro.pdf
 21. Deschênes SS, Burns RJ, Schmitz N. Associations between diabetes, major depressive disorder and generalized anxiety disorder comorbidity, and disability: Findings from the 2012 Canadian Community Health Survey - Mental Health (CCHS-MH). *J Psychosom Res*. 2015;78(2):137-42.
 22. Groce NE, Mont D. Counting disability: emerging consensus on the Washington Group questionnaire. *Lancet Glob Health*. 2017;5(7):e649-50.
 23. Instituto Nacional de Estadística e Informática. Cédula Censal. En: *Censos Nacionales 2017*. [Internet]. INEI; 2017. [Citado 20 Ene 2022]. Disponible en: <http://censo2017.inei.gob.pe/cedula-censal/>
 24. Sánchez-Villegas A, Schlatter J, Ortuno F, Lahortiga F, Pla J, Benito S, et al. Validity of a self-reported diagnosis of depression among participants in a cohort study using the Structured Clinical Interview for DSM-IV (SCID-I). *BMC Psychiatry*. 2008;8:43.
 25. Comino EJ, Tran DT, Haas M, Flack J, Jalaludin B, Jorm L, et al. Validating self-report of diabetes use by participants in the 45 and up study: a record linkage study. *BMC Health Serv Res*. 2013;13(1):481.
 26. Jackson JM, Defor TA, Crain AL, Kerby TJ, Strayer LS, Lewis CE, et al. Validity of Diabetes Self-Reports in the Women's Health Initiative. *Meno-pause*. 2014;21(8):861.
 27. Li HL, Fang J, Zhao LG, Liu DK, Wang J, Han LH, et al. Personal Characteristics Effects on Validation of Self-reported Type 2 Diabetes From a Cross-sectional Survey Among Chinese Adults. *J Epidemiol*. 2020;30(11):516-21.
 28. Levy NS, Palamar JJ, Mooney SJ, Cleland CM, Keyes KM. What is the prevalence of drug use in the general population? Simulating underreported and unknown use for more accurate national estimates. *Ann Epidemiol*. 2022;68:45-53. [Online antes de impresión].
 29. Instituto Nacional de Estadística e Informática. Bases de datos. [Internet]. INEI. [Citado 9 Feb 2019]. Disponible en: <https://www.inei.gob.pe/bases-de-datos/>
 30. Semenkovich K, Brown ME, Syrakic DM, Lustman PJ. Depression in type 2 diabetes mellitus: Prevalence, impact, and treatment. *Drugs*. 2015;75(6):577-87.
 31. Khan A, Petropoulos IN, Ponirakis G, Malik RA. Visual complications in diabetes mellitus: beyond retinopathy. *Diabet Med*. 2017;34(4):478-84.
 32. Rolim LP, Samelli AG, Moreira RR, Matas CG, Santos I de S, Bensenor IM, et al. Effects of diabetes mellitus and systemic arterial hypertension on elderly patients' hearing. *Braz J Otorhinolaryngol*. 2018;84(6):754-63.
 33. Parmar MC, Saikia N. Chronic morbidity and reported disability among older persons from the India Human Development Survey. *BMC Geriatr*. 2018;18(1):299.
 34. Liu T, Lee JE, Wang J, Ge S, Li C. Cognitive Dysfunction in Persons with Type 2 Diabetes Mellitus: A Concept Analysis. *Clin Nurs Res*. 2020;29(5):339-51.
 35. Morimoto SS, Kanellopoulos D, Manning KJ, Alexopoulos GS. Diagnosis and treatment of depression and cognitive impairment in late life. *Ann N Y Acad Sci*. 2015;1345(1):36-46.
 36. Li M, Yang Y, Pang L, Wu M, Wang Z, Fu Y, et al. Gender-specific associations between activities of daily living disability and depressive symptoms among older adults in China: Evidence from the China Health and Retirement Longitudinal Study. *Arch Psychiatr Nurs*. 2019;33(6):160-6.