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Association Between Tobacco Consumption and Self-Reported Visual Impairment in Adults of High-Altitude Andean Communities of Peru

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Emilyn N. Paitan-Quispe[1], Kathleen H. Pérez-Castillo[1], Kiara Camacho-Caballero[1,2], Maria Alejandra Rodriguez-Cuba[1,2], Fernando M. Runzer-Colmenares[1,2], and Jose F. Parodi[3]

Abstract

To determine the association between tobacco consumption and self-reported visual impairment. We performed a cross-sectional study based on an original cohort study. A non-probabilistic sampling was performed to invite 413 patients of 60 years or more from 11 high-altitude Andean communities (altitude higher than 1500 m above sea level) of Peru between 2013 and 2017. Demographic data and information on tobacco consumption were collected. Associations were determined using a Poisson regression model with 95% confidence intervals (CI). Of the 413 participants, 141 (34.14%) were men and 49 (11.86%) were tobacco users. In the adjusted model, tobacco users presented a high probability of visual impairment with a prevalence ratio of 1.32 (95% CI: 1.18–1.97). We also found that having two or more comorbidities 2.19 (95% CI: 1.53–3.15), receiving health assistance in a pharmacy 3.75 (95% CI: 1.97–7.16), and coffee consumption 1.67 (95% CI: 1.26–2.21) were factors significantly associated with self-reported visual impairment. We determined that in Peruvian high-altitude Andean communities, visual impairment was more frequent in individuals reporting tobacco consumption, taking alternative medicine, going directly to a drug store without primary care physician consultation, having more than one comorbidity, and coffee consumption.

Keywords

elderly, geriatrics, high altitude, tobacco consumption, visual impairment

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Introduction

Tobacco consumption is one of the main risk factors of mortality around the world, being responsible for more deaths than illegal drugs, the human immunodeficiency virus, murders, motor vehicle injuries, and suicides combined (Singh & Kathiresan, 2015). Around 23% globally smoke cigarettes, being 32% men and 8% women (Adams & Morris, 2020). Nonetheless, despite knowledge regarding the negative effects of smoking, tobacco consumption continues to rise, most likely because nicotine, one of the main chemicrals found in cigarettes, produces addiction making it very difficult for some people to overcome this vice (West, 2017).

[1]Facultad de Ciencias de la Salud, Universidad Científica del Sur, Miraflores, Lima, Perú
[2]CHANGE Research Working Group, Carrera de Medicina Humana, Universidad Científica del Sur, Miraflores, Lima, Perú
[3]Universidad San Martin de Porres Facultad de Medicina Humana Centro de Investigación del Envejecimiento (CIEN), Universidad San Martín de Porres, La Molina, Lima, Perú

Corresponding Author:
Fernando M. Runzer-Colmenares, Facultad de Ciencias de la Salud, Universidad Científica del Sur, Lima, PerúCantuarias 385, Miraflores, Lima, Peru.
Email: frunzer@cientifica.edu.pe

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Older adults are more vulnerable to the toxic effects of smoking, such as cardiovascular disease, chronic lung diseases, cancer, and even predisposition to ophthalmologic diseases (Sayin et al., 2014). It has been shown that in vulnerable populations such as older adults who smoke, the toxic effect of tobacco is even greater, causing discomfort and visual disturbances (Carreras Castellet et al., 2001). It is also known that age-related macular degeneration (AMD) is the main cause of unmodifiable and severe visual impairment worldwide. Some literature affirmed that when someone smokes a cigarette, the chemicals that are inhaled are absorbed through the lungs and pass along the bloodstream. The carbon monoxide that cigarette contains holds to the hemoglobin in the red blood cells, depriving the oxygen to cells and to the body because it prevents affected cells from carrying a full load of oxygen (Kennedy et al., 2011). Although age is the most important risk factor, smoking is correlated with a two-fold increase of the development of AMD.

However, the lay population is largely unaware of the relationship between smoking and vision impairment (Brûlé et al., 2018; Evans et al., 2005; Thornton et al., 2005). In a self-reported study on visual impairment due to age-related eye diseases, it was shown that in a model adjusted for gender, ethnicity, education, and general health status, smokers presented greater visual impairment compared to subjects who had never smoked, being statistically significant with an odds ratio (OR) of 1.16 (1.02–1.32, $p < 0.05$) (Zhang et al., 2011).

Besides, some studies have shown the absence of an association between tobacco consumption and ophthalmological disease. For example, a study on risk factors for glaucoma did not show any association with the previous smoking habit (Le et al., 2003). Additionally, a systematic review found no consistent association between smoking and macular degeneration, reporting that the time of consumption was a more important factor than the dose itself (Thornton et al., 2005).

While some studies have reported a relationship between tobacco consumption and ocular diseases, other studies have shown no relationship (Le et al., 2003). On the other hand, literature refers that a high-altitude environment represents natural short- and long-term stress affecting the visual system which can be found in individuals living at high altitudes

Table 1. Bivariate Analysis of Patient's Characteristics and Visual Impairment (n = 413).

	No impairment (%)	Impairment (%)	p value		No impairment (%)	Impairment (%)	p value
Sex				Functional dependence			
Female	201 (70.77)	71 (55.04)	0.002	No	97 (34.15)	32 (24.81)	0.05
Male	83 (22.93)	58 (44.96)		Yes	187 (65.85)	97 (75.19)	
Age				Rural area			
60–70	117 (41.49)	51 (39.53)	—	No (urban)	216 (76.06)	53 (41.09)	0.01
71–80	121 (42.91)	57 (44.19)	0.932	Yes	68 (23.94)	76 (58.91)	—
More than 80	44 (15.60)	21 (16.28)	—	—	—	—	—
Work status				Comorbidities			
No	146 (51.41)	52 (40.31)	0.036	0	99 (42.49)	27 (21.60)	—
Yes	138 (48.59)	77 (59.69)	—	1	68 (29.18)	49 (39.20)	0.01
—	—	—	—	More than 2	66 (28.33)	49 (39.20)	—
Level of education				Coca leaf consumption			
Elementary school	229 (80.63)	111 (86.05)	—	No	249 (87.68)	88 (68.22	0.01
High school	54 (19.01)	17 (13.18)	0.301	Yes	35 (12.32)	41 (31.78)	
University	1 (0.35)	1 (0.78)	—	—	—	—	—
Self-reported health status				Coffee consumption			
Excellent	1 (0.35)	13 (10.08)	—	No	247 (86.97)	77 (60.16)	0.01
Very good	4 (1.41)	18 (13.95)	0.01	Yes	37 (13.03)	51 (39.84)	
Good	22 (7.75)	11 (8.53)	—	—	—	—	—
Regular	87 (30.63)	36 (27.91)	—	—	—	—	—
Poor	170 (59.86)	51 (39.53)	—	—	—	—	—
Living status				Alcohol consumption			
Not alone	228 (80.28)	92 (71.88)	0.058	No	196 (69.01)	98 (75.97)	0.148
Alone	56 (19.72)	36 (28.13)		Yes	88 (30.99)	31 (24.03)	
Access to health care				Tobacco consumption			
Primary care	168 (59.15)	35 (27.13)		Yes	256 (90.14)	108 (83.72)	0.05
Self-medication	27 (9.51)	10 (7.75)	0.01	No	28 (9.86)	21 (16.28)	
Alternative medicine	86 (30.28)	79 (61.24)	—	—	—	—	—
Pharmacy	3 (1.06)	5 (3.88)	—	—	—	—	—

(Jha, 2012). Hypoxia-induced retinopathy, corneal thickness, high-altitude dry eye syndrome, photoconjunctivitis, and photophthalmia are eye-related complications described in long-term high-altitude exposure (Arjamaa & Nikinmaa, 2006; Morris et al., 2007).

In the absence of strong evidence and the controversy between tobacco use and visual impairment in the elderly population living in high-altitude Andean communities, this study aimed to assess and strengthen the possible association between self-reported visual impairment and a history of tobacco consumption in older adults from high-altitude Andean communities in Peru.

Methods

Study design

We conducted a retrospective cross-sectional analysis of a database. We studied the database of a study including 413 participants over 60 years of age from 11 Peruvian high-altitude Andean communities assessed between 2013 and 2017. High-altitude Andean communities were considered those located 1500 m above sea level (Meucci et al., 2020).

Population and Sample

The sampling was not probabilistic. The inclusion criteria were age greater than 60 years, complete data of tobacco consumption, and self-report of visual impairment.

Variables. As a dependent variable, we included "visual impairment" assessed with the following question: "Do you have visual problems that limit your daily living?" and it was classified as dichotomic "Yes" or "No." As an independent variable, we included self-reported tobacco consumption obtained with the following question: "Are you a tobacco user?" and it was classified as dichotomic "Yes" or "No."

In addition, we included other demographic data including sex (male and female), age in years (60–70, 71–80, and >80), level of education (primary level, secondary level, and high school), marital status (single, married, divorced, and widow), self-reported health status (excellent, very good, good, regular, and poor), access to health care (primary care, self-medication, traditional medicine, and pharmacy), and comorbidities (hypertension, diabetes, chronic obstructive pulmonary disease, depression, arthrosis, and overweight/obesity). Other dichotomous variables included alcohol, coffee, and coca leaf consumption, living in rural areas, living alone, and work status (self-reported working status despite retirement).

Analysis. The database was exported to Stata 15.0. Categorical variables were expressed as frequencies and percentages. We performed a bivariate analysis (Table 1) based on the dependent variable using the chi-square test. Finally, in order to identify the association between self-reported tobacco consumption and self-reported visual impairment, we constructed Poisson regression models after ensuring the meeting of assumptions (independence between variables and variance assumption). The multivariate model was adjusted for sex, self-reported health status, living alone, working status, access to health care, living in a rural area, the number of comorbidities, coca leaf, and coffee consumption. The associations were expressed as prevalence ratios (PR) and their confidence intervals (95% CI).

Ethical Considerations. Informed consent was not required since we performed a secondary analysis of a database, information was encoded, and the project was approved by the Research Ethics Committee of the school of medicine of the "Universidad Científica del Sur" (137CIEI-CIENTIFICA2019).

Table 2. Socio-Demographic Characteristics of the Study Sample (n = 413).

	n	%		n	%
Sex			Functional dependence		
Female	272	65.86	No	129	31.23
Male	141	34.14	Yes	284	67.77
Age			Rural area		
60–70	168	40.88	No	269	65.13
71–80	178	43.31	Yes	144	34.87
More than 80	65	15.82	—	—	—
Level of education			Comorbidities		
Elementary school	340	82.32	0	126	35.2
High school	71	17.19	1	117	32.68
University	2	0.48	More than 2	80	22.35
—	—	—	More than 3	35	9.78
Civil status			Coca leaf consumption		
Single	44	10.65	No	337	81.6
Married	240	58.11	Yes	76	18.4
Divorced	11	2.66	—	—	—
Widow	118	28.57	—	—	—
Self-reported health status			Coffee consumption		
Excellent	14	3.39	No	324	78.64
Very good	22	5.33	Yes	88	21.36
Good	33	7.99	—	—	—
Regular	123	29.78	—	—	—
Poor	221	53.51		—	—
Living status			Alcohol consumption		
Not alone	320	77.67	No	294	71.19
Alone	92	22.33	Yes	119	28.81
Work			Tobacco consumption		
No	198	47.94	No	364	88.14
Yes	215	52.06	Yes	49	11.86
Access to health care			—	—	—
Primary care	203	49.15	—	—	—
Self-medication	37	8.96	—	—	—
Alternative medicine	165	39.95	—	—	—
Drug store	8	1.94	—	—	—

Results

Data from 431 participants over the age of 60 years were analyzed; 272 (65.86%) were female, 178 (43.31%) were between 78 and 80 years, 240 (58.11%) were married, and 215 (52.06%) working. Overall, 49 (11.86%) individuals were smokers, 221 (53.51%) subjects considered that they had poor health, 203 (49.15%) had access to health care in a primary care center, and 165 (39.95%) opted for the use of alternative medicine. A total of 117 (32.68%) participants had one comorbidity, while 80 (22.35%) had more than two comorbidities and 35 (9.78%) had more than three comorbidities. Additionally, 144 (34.87%) lived in rural areas. Table 2 shows the socio-demographic characteristics of the study participants.

In the bivariate analysis, we found different associations statistically significant between visual impairment and the variable sex, where the patients with visual impairment there was a higher frequency of females; with the variable work status, where the frequency of older adults that keep working and have visual impairment was 59.69% (n = 77); with the variable self-reported health status, where the older adults with visual impairment were 39.53% (n = 51) and reported poor self-reported health status; and functional dependence, where 75.19% (n = 97) had coexistence between visual impairment and functional dependence. Additionally, regarding to residence area, 58.91% (n = 76) of participants with visual impairment lived in rural areas, 39.20% (n = 49) had two or more comorbidities, 31.78% (n = 41) consumed coca leaf, and 39.84% (n = 51) of the participants that had visual impairment consumed coffee.

In the adjusted model (Table 3), the highest likelihood of finding visual impairment was found among smokers with a PR of 1.32 (95% CI: 1.18–1.97; $p < 0.01$). Comparison between the population without any comorbidity and those with two or more comorbidities showed a 2.19-fold higher probability of having a visual impairment (95% CI: 1.53–3.15; $p < 0.01$). In addition, the presence of visual impairment was greater in participants who had access to health care in a pharmacy with a PR of 3.75 (95% CI: 1.97–7.16; $p < 0.01$) compared to those attended in a primary care center. The proportion of visual impairment among coffee consumers was 1.67-fold greater compared to non-coffee consumers (95% CI: 1.26–2.21; $p < 0.01$). However, living in a rural area had a weak negative association with the presence of visual impairment (PR 0.64; 95% CI: 0.46–0.89), and visual impairment was less frequent among participants with self-reported excellent and very good health, (PR 0.43 95% CI: 0.28–0.67; $p < 0.01$) and (PR 0.53 95% CI: 0.34–0.83; $p < 0.01$), respectively.

With the use of the Open Epi software version 3.0, using an analytical design formula, and assuming a 95% confidence interval (CI), the frequency of visual impairment in smokers and non-smokers > 60 years old was 48.2% and 41.6%,

Table 3. Adjusted Model for Visual Impairment and Associated Factors.

	Crude PR[a]	Adjusted PR[a] (CI 95%)		Crude PR[a]	Adjusted PR[a] (CI 95%)
Tobacco consumption			Functional dependence		
Yes	1.44 (1.01–2.07)	1.32 (1.18–1.97)	Yes	1.34 (1.07–1.94)	1.21 (0.90–1.63)
Sex			Rural area		
Male	1.58 (1.11–2.23)	1.19 (0.92–1.55)	Yes	0.37 (0.28–0.50)	0.64 (0.46–0.89)
Living status			Comorbidities		
Alone	1.36 (1.01–1.85)	0.85 (0.55–1.31)	0	Reference	Reference
—	—	—	1	1.95 (1.31–2.91)	1.79 (1.25–2.57)
—	—	—	More than 2	1.99 (1.34–2.96)	2.19 (1.53–3.15)
Work status			Coca leaf consumption		
Yes	1.36 (1.02–1.83)	1.20 (0.90–1.59)	Yes	2.07 (1.57–2.72)	0.75 (0.55–1.03)
Access to health care			Coffee consumption		
Primary care	Reference	Reference	Yes	2.44 (1.87–3.18)	1.67 (1.26–2.21)
Self-medication	1.57 (0.85–2.88)	1.27 (0.71–2.27)	—	—	—
Alternative medicine	2.78 (1.97–3.91)	1.65 (1.18–2.29)	—	—	—
Pharmacy	3.63 (1.96–6.71)	3.75 (1.97–7.16)	—	—	—
Self-reported health status			—	—	—
Excellent	0.25 (0.14–0.46)	0.43 (0.28–0.67)	—	—	—
Very good	0.32 (0.17–0.59)	0.53 (0.34–0.83)	—	—	—
Good	0.36 (0.16–0.80)	0.56 (0.31–1.02)	—	—	—
Regular	0.88 (0.43–1.80)	0.85 (0.56–1.29)	—	—	—
Poor	Reference	Reference	—	—	—

[a]PR: prevalence ratio

respectively, and with a sample size of 413 participants, the statistical power for this study was 88.32%.

Discussion

In our study, we found a frequency of tobacco consumption in high-altitude Andean areas of 11% compared to 5.5% described in another Peruvian cohort study about self-reported smoking data in peri-urban Peruvian communities in participants older than 65 years of age (Morgan et al., 2017). Tobacco consumption in Peru is reported to be higher in urban and less in rural areas, similar to what was described in the previously mentioned study. Nevertheless, in more than 80% of our participants, the level of education was only of an elementary level, which is consistent with a previous Peruvian study in older adults in high-altitude communities in which 82.7% of the sample had no education or had an incomplete elementary schooling. This is important to take into account because people with a higher education are generally healthier, have fewer comorbidities, and live longer than people with less education (Davies et al., 2018; Urrunaga-Pastor et al., 2018). Only 35.2% of all the participants reported having no comorbidities, which is comparable to another study in a very similar population in which the absence of comorbidities was 44% and may be due to the similar demographic characteristics and inequities of health services in the study areas (Urrunaga-Pastor et al., 2018).

In the present study, 83% of smokers reported having visual impairment. These results are in agreement with those of a study in which the prevalence of visual impairment was higher among current (48%) compared to former smokers (41%) (Zhang et al., 2011). In addition, one study showed that consumption of more than 30 cigarettes per day had an elevated risk of visual impairment associated with age-related cataracts compared with non-smokers (Al-Zamil & Yassin, 2017). One study reported that cigarette smoking for more than 40 years was a risk factor for AMD, while another study found that increased smoking according to pack-years is related to visual impairment (McCarty et al., 2001; Merle et al., 2018). Indeed, of the 4000 active substances found in tobacco smoke, most are hazardous to human health (Office on Smoking and Health (US), 2006) and can lead to the development of tobacco-related ocular diseases including AMD, thyroid ophthalmopathy, cataracts, ocular ischemia, tobacco-alcohol amblyopia, primary open-angle glaucoma, diabetic retinopathy, and ocular irritation, the latter being more related to passive smoking (Lois et al., 2008). Even though our findings are similar to those of other studies, it is difficult to extrapolate our results to other populations since this study was set in a high-altitude Andean population, in which the geography and social characteristics may also be associated with visual impairment (Fortunato & Drusini, 2005).

It is known that socioeconomic status, geographic location, access to healthcare services and resources, and having private insurance are factors that can affect visual impairment (Livingston et al., 1997). In our study, we found that visual impairment was more likely in individuals who smoked in addition to those choosing alternative medicine, going directly to a drug store without primary care physician consultation, coffee consumption, and having more than one comorbidity. Most of these factors can be explained by the low access to health care as explained above. However, coffee consumption has also been described in relation to the development of ocular diseases, which is thought to occur by mechanisms such as the induction of oxidative stress through the intraocular formation of oxygen-free radicals. Even though coffee contains antioxidants, they are destroyed while roasting the raw coffee beans before preparation explaining the under-protection of oxidative stress (Varma, 2016). Another small trial demonstrated that with an increase in caffeine dosage, the level of reported visual disturbances increased, probably explained by the interaction of caffeine with structural properties of the visual cortex (Coren, 2002). Another study demonstrated that in patients at risk for primary open-angle glaucoma, having only one cup of caffeinated coffee statistically increases intraocular pressure and ocular perfusion pressure without clinical impact (Jiwani et al., 2012; Lorem et al., 2020). This information helps in understanding the multifactorial causes of visual impairment in our population and the risk induced by harmful habits such as coffee intake and mention in references cited in this paragraph (Coren, 2002).

Self-medication instead of consultation with a primary care physician was another harmful habit found in this study. This result is similar to that reported in another study on visual impairment and associated factors, in which socioeconomic status, geographic location, access to health services and resources, and having private insurance were found to affect visual impairment (Livingston et al., 1997). The prevalence of self-medication and the use of alternative medicine of almost 70% in our study are comparable to previously published rates. For example, in a study also carried out in Perú, the prevalence of alternative medicine and self-medication was 35%, this difference in rate can be explained by the socioeconomic barriers that hinder access to primary care in some rural and high-altitude Andean areas of Peru (Gutiérrez et al., 2018).

Visual impairment was less commonly reported in persons self-reporting excellent and very good health and belonging to a rural area. In a prospective cohort study, Lorem and colleagues found an increased risk of all-cause mortality in subjects self-reporting poor health including the presence of comorbid diseases such as hypertension, hyperlipidemia, high body mass index, and smoking (Lorem et al., 2020). In another study performed on rural residents in Perú, the perception of poor health was related to poor physical performance, deterioration of emotional state, and dissatisfaction with life (Estela-Ayamamani et al., 2015). We believe that as our findings are part of a cross-sectional study, we cannot

expect an impact such as that described in the studies cited previously (Lorem et al., 2020; Estela-Ayamamani et al., 2015). However, it is reasonable to assume that excellent or very good health is not related to visual impairment.

Finally, we compared self-reported visual impairment in high-altitude urban and rural areas and found that participants living in urban areas had a lower prevalence of self-reported visual impairment compared to those living in rural areas. However, the adjusted models showed that belonging to a rural area was related to less self-reporting of visual impairment. We can compare our findings with an Iranian study on the prevalence of visual impairment in underserved rural areas, in which it was found that the prevalence of visual impairment was higher in these areas and was related to lack of access to health services (Hashemi et al., 2017). Taking this into account, in 2015, Peruvians seeking medical care decreased to 31.7% among those with government health insurance aimed at vulnerable people without private, military, or employee insurance (Gutiérrez et al., 2018). Nonetheless, our findings of the risk of visual impairment in vulnerable high-altitude rural and urban Andean populations might have been the same for the two populations if only geographic location had been considered; however, tobacco consumption is more prevalent in urban areas.

Our study has several limitations, one of which is that on being a cross-sectional study, we were not able to evaluate causality because there was no follow-up. There could have also been an information bias because information on tobacco consumption and visual impairment was self-reported. However, it has been described that 11 out of 12 people with normal vision acuity will self-report normal vision, while three in every four respondents with low vision acuity will also self-report normal vision (Whillans & Nazroo, 2014). In this latter study, the results were not associated with the age of the patient, but they were significantly associated with the level of wealth, meaning that both subjective and measured assessments of visual impairment were more common in the lower wealth quintiles. However, we had a larger urban population meaning that it is possible that the frequency of tobacco consumption might have been higher among urban residents.

Conclusions

Visual impairment can be due to multifactorial causes. In Peruvian high-altitude Andean communities, visual impairment was more frequent in individuals reporting tobacco consumption, taking alternative medicine, going directly to a drug store without primary care physician consultation, having more than one comorbidity, and coffee consumption. We recommend in primary care a more effective screening of visual diseases and their risk factors should be carried out for referral to specialists in a more timely manner. Additionally, carrying more longitudinal studies establishes causality association.

Declaration of Conflicting Interests

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ORCID iD

Emilyn N. Paitan-Quispe https://orcid.org/0000-0003-2285-1730

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