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SURVIVAL AND MORTALITY IN OLDER ADULTS LIVING AT HIGH ALTITUDE IN BOLIVIA: A PRELIMINARY REPORT

To the Editor: Approximately 400 million people live permanently at altitudes above 1,500 m.[1] High-altitude communities reportedly have higher prevalence of Parkinson's disease,[2] migraine,[3] chronic obstructive pulmonary disease,[4] and chronic mountain sickness,[5] which may affect survival and mortality, although epidemiological evidence is lacking. To address this limitation of the literature, data relating to age at death and causes of death were obtained for grandparents of participants in the Bolivian Children Living at Altitude (BoCLA) Study.[6]

Information regarding the grandparents of 280 children participating in BoCLA was requested from parents, including whether grandparents were alive or dead, current age or age at death, municipality of residence, major health concerns, and cause of death. Families recruited to BoCLA were selected from mid to high socioeconomic strata to limit the effect of cultural diversity and to prevent bias from differences in nutrition and education. For this retrospective report on children's grandparents, the altitude of current or last municipality of residence was coded as low (LA; 0–1,499 m), moderate (MA; 1,500–2,999 m), or high (HA; $\geq$ 3,000 m) altitude. Lifetime data on age at survey for living participants and life duration for participants who had died were obtained. Sex, frequent diseases, family income, housing standards, and access to medical care described by BoCLA participant families were used as predictors in subsequent multivariate regression models. Distributions of these variables are frequently different between altitude populations in Bolivia.[7]

The sample consisted of 555 distinct grandparents (mean age $\pm$ standard deviation 64.4 $\pm$ 11.0; 54% women) distributed across LA (alive/dead n = 143/12), MA (n = 138/36), and HA (n = 161/65) categories. Income level, housing standards, and medical care access, estimated from that of the son or daughter (BoCLA parents), were comparable across altitude locations (Wilcoxon, Mann-Whitney tests, $P > .05$). Hypertension and diabetes mellitus were the only prevalent diseases, but two- and three-way nonparametric comparisons across altitude groups were not significant ($P > .05$). The most frequently reported causes of death involved cardiovascular system disease or complications (including myocardial infarction and stroke), cancer, and respiratory disease (including pneumonia). Cardiovascular system disease or complications as cause of death were less common at HA and MA than LA (Kruskal-Wallis, $P < .001$).

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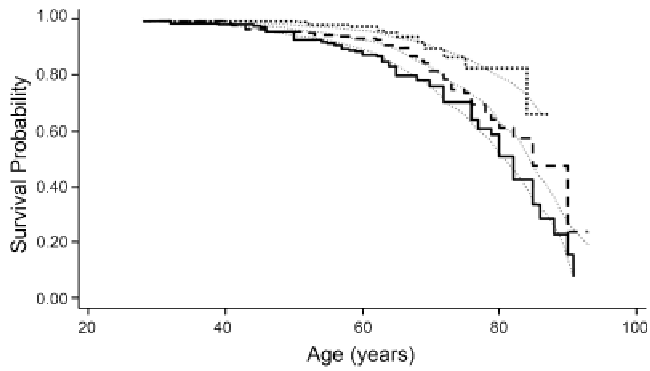

	HR*	SE*	95% CI*	P value
Altitude of residence				
········ (Low altitude 0-1,499 m)*				
– – – Mid altitude 1,500-2,999 m	1.98	0.664	1.03, 3.83	0.040
——— High altitude ≥3,000 m	2.92	0.922	1.58, 5.43	0.001

Figure 1. Survival curves for older residents living at low, moderate, and high altitude in Bolivia. Dashed-dotted lines represent predicted survival according to univariate Cox regression. *Reference category in parenthesis. Proportional hazards chi-square (χ^2) (2) = 1.63, $P = .44$. Sex, access to medical care, self-reported income, basic housing standards (electricity, piped water, flush toilet, nondirt floor), and offspring-reported diagnosis of hypertension and diabetes mellitus did not improve goodness of fit when entered one by one into the model (likelihood ratio χ^2, $P > .10$). HR = hazard ratio; SE = standard error; CI = confidence interval.

Cumulative survival functions were estimated using the Kaplan-Meier method to compare explanatory factors. Altitude of residence was the only significant predictor (Figure 1). Lower survival is apparent throughout a wide age range, with a several-fold difference between LA and HA. Survival proportions varied significantly across altitude groups, from 91% at LA to 60% at HA (log rank test, chi-square (χ^2) = 13.92, $P < .001$; Wilcoxon test, χ^2 = 13.44, $P < .001$). Two-way comparisons showed that survival was lower in the MA and HA samples than LA (log rank test, $\chi^2 = 4.01$, $P = .05$; Wilcoxon test, $\chi^2 = 4.38$, $P < .05$; $\chi^2 = 13.27$, $P < .001$; $\chi^2 = 12.83$, $P < .001$, respectively). There was no difference between MA and HA samples ($P > .05$). The log rank test was nonsignificant for all other predictors. Independent univariate Cox regression analyses showed no prognostic value for sex, self-reported income, housing standards, access to medical care, or prevalent diseases, including hypertension and diabetes mellitus ($P > .5$). The final Cox regression model included altitude of residence as the only predictor (see predicted curves, Figure 1).

This study shows that, in older adults, life span is shorter over 1,500 m, indicating that high-altitude living may be detrimental to health despite the otherwise expected protection offered by physiological adaptations to chronic hypoxia. Comparable with earlier reports of greater prevalence of common ischemic and coronary conditions at high altitude,[8,9] the data from the current study show greater frequency of cardiovascular system disease and complications in the living but less likelihood of this being described as cause of death. This requires more-detailed investigation in larger prospective epidemiological studies. Overall, the data suggest greater all-cause mortality at higher altitudes.

The retrospective design of this study, its reliance on offspring report rather than medical record, and a lack of control for potential confounders such as genetic admixture and diet are significant limitations and mean that the results must be interpreted cautiously, but this preliminary report, using opportunistic data obtained as part of the BoCLA study, suggests that a combination of environmental and physiological stressors, present across the life span, may account for shorter survival at high altitude. This may provide the impetus for further research to determine the nature of these stressors and the mechanisms by which they reduce lifespan in those living at high altitude and perhaps also in those living at the sea level with diseases causing pathological chronic hypoxia at sea level.

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DELIRIUM IN NURSING HOME RESIDENTS ACROSS CARE TRANSITIONS: A PRELIMINARY REPORT

To the Editor: Delirium affects patients in many settings,[1–3] leading to adverse outcomes. Nursing home (NH) patients are three times more likely to present to an emergency department (ED) with delirium than community-dwelling