Bull Pan Am Health Organ 14(1), 1980

THE AYMARA OF WESTERN BOLIVIA: HEALTH AND DISEASE[1, 2]

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The world medical community has long been interested in altitude-related disease and disability among residents of high Andes towns and villages. Nevertheless, with few exceptions, data on this subject have been rather limited. To help fill the gap, a number of academic and government institutions in Bolivia, Chile, Ecuador, Peru, and the United States have been collaborating on a broad research effort known as the Multinational Andean Genetic and Health Program. This article reports the results of one part of that program—involving examination of 429 people living in two highland communities of western Bolivia.

Introduction

Western Bolivia is situated on a lofty intermontane plateau, the Andean *altiplano*, which begins hundreds of miles to the north near the Peru-Ecuador border and extends southward through Bolivia into Argentina and Chile. Through most of Bolivia it is some 80 miles wide or so, varying in altitude from 3,600 to 4,500 meters. From the center of this 80-mile expanse the *altiplano* tilts upward—toward the eastern mountain range (*Cordillera Oriental*) on the one hand and the western mountain range (*Cordillera Occidental*) on the other. Starting out from Lake Titicaca in the north, the plateau gradually descends to a land of salt flats in the south. Nights are cold, even in summer. Rains are seasonal and rainfall modest, save in the immediate vicinity of Lake Titicaca—where as much as 40 inches can fall annually. Natural vegetation is sparse, but potatoes and indigenous cereals are widely cultivated. Cattle and sheep are husbanded, the former less successfully than the latter; the authochthonous alpaca and llama serve as beasts of burden and sources of meat and wool.

Scattered across this undulating plateau are the villages and towns of three groups of people—the Aymará, Quechua, and Uru-Chipaya—who can be distinguished by the different languages they speak (*1*). Of the three, we are here concerned only with the Aymará; the latter presently number a million or so individuals, most of whom reside in the Departments of La Paz and Oruro (*2*). Surprisingly little is known, or at least has been published, about disease and disability among these peoples. Evidence suggests that they are better adjusted to the hypoxia or altitude than are indigenous coastal dwellers, but their adjustments (which may promote oxygen transport and utilization) may also have deleterious consequences in the long run. Thus, for example, adjustments involving

[1] Also appearing in Spanish in the *Boletín de la Oficina Sanitaria Panamericana*, 1980.

[2] The research reported here was supported by two grants (Nos. HL-15614 and 1F05TW021-11-01) from the National Heart, Lung, and Blood Institute, National Institutes of Health of the United States.

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increased hematopoesis can lead to an increased frequency of gall bladder and liver disease, as well as to an elevated serum uric acid level resulting from increased red cell destruction. Elevated serum uric acid appears to be a coronary risk factor in some populations, although admittedly not a certain one. In Framingham, Massachusetts, an association was found between elevated hemoglobin and hematocrit—both characteristic of high-altitude dwellers—and increased risk of coronary artery disease (*3*); this observation has been confirmed elsewhere. Also, polycythemia is known to predispose subjects to thrombus formation, and there is ample physiological evidence suggesting that increased blood viscosity, as measured by hematocrit levels, should increase the risk of coronary heart disease.

Methodology

The Bolivian Aymará Health Study

The investigation described here is part of a larger study, known as the Multinational Andean Genetic and Health Program, that was initiated in Chile in 1973 (*4*). Broadly stated, the goal of this program is to appraise the contribution genetic factors have made to man's adaptation to hypoxia. More specifically, it seeks the following five objectives:

First, it seeks to evaluate the effects of environmental differences, particularly oxygen tension, upon pulmonary function, cardiopulmonary relationships, and degenerative cardiac disease in the Aymará, and to assess the contribution of genetic factors to the Aymará's anatomical, biochemical, and physiological responses.

Second, it aims to evaluate the burden of disease and disability prevailing in populations residing at these altitudes and practicing the forementioned types of agriculture and animal husbandry.

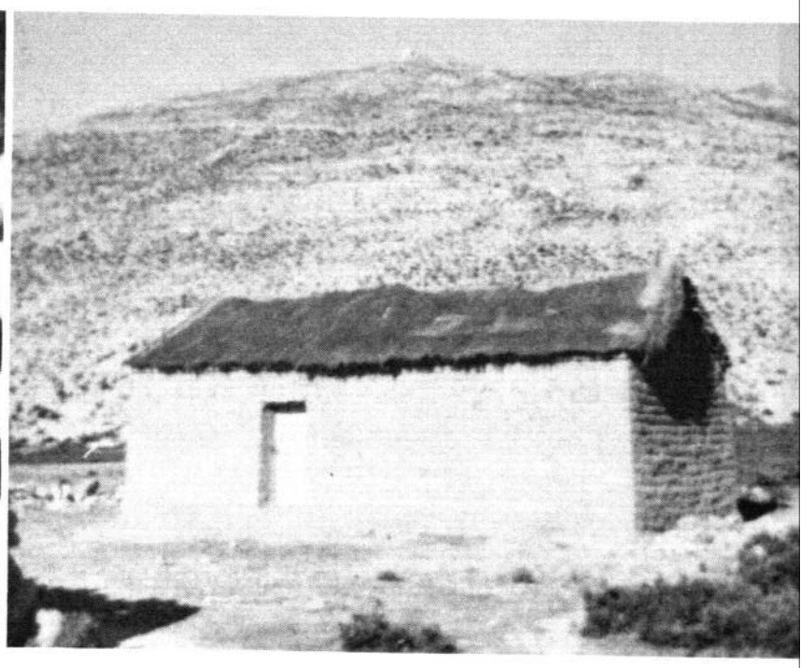
Third, it proposes to measure some of these people's normal blood constituents (cholesterol, glucose, and serum uric acid), constituents that have been associated elsewhere with an increased risk of coronary artery disease.

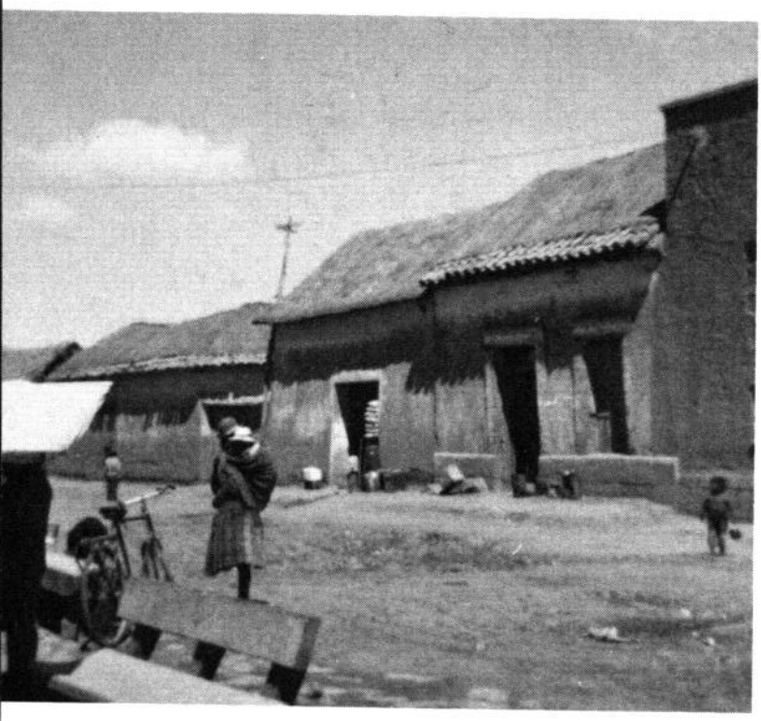
Fourth, by assessing the frequencies of a number of biochemical and immunological genetic markers, it seeks (a) to identify the extent, if any, of the non-indigenous contribution to the present gene pool, and (b) to single out those simply inherited biochemical variants that appear to be responding directly (in terms of frequency) to changes in oxygen tension.

And *fifth*, it seeks to measure as many of the glycolytic intermediates involved in the regulation of oxygen transport as is practicable.

In working toward these objectives, it soon became apparent that the Chilean *altiplano* is somewhat different from much of the *altiplano* in Bolivia and Peru. The former is generally higher, although possibly not significantly so from a physiological or adaptational point of view; it is also drier, and seemingly more inimical. Cereals do not do as well, potato cultivation is more limited, the bearing capacity of the land seems less, and in fact the population is sparser. Moreover, there are differences in settlement patterns that may influence behavior and ultimately disease and disability. Therefore, besides studying the Chilean *altiplano* villages, it seemed prudent to study villages in the Bolivian *altiplano* as well.

The Bolivian phase of the program was conducted in Oruro Department, in the villages of Turco (3,980 m) and Toledo (3,752 m). These villages, respectively, are some 240 km west and 40 km southwest of Oruro, the department capital. Oruro, in turn, has an altitude of 3,702 m and is situated some 239 km southwest of Bolivia's capital, La Paz. Turco, which according to a village census has 314 inhabitants, can be described as a quiet collection of uninteresting dwellings, each with its own outside baking oven, nestled between a small river and a





Different scenes of the Aymará environment (counter-clockwise): an Aymará dwelling, the store, a typical street, the polyclinic where authors performed examinations, and market day in the main square.

mountainside. The town is served by a Catholic Church with a resident priest—usually one of Canadian or Belgian origin. The church's baptismal records begin in 1580. Basic (four years), intermediate (four years), and media (four years) schools also exist, as well as a clinic staffed by a nurse who tends to the medical needs of the community. The village water supply comes from springs; no electricity is available; mail and transportation services are confined to the dry season.

Toledo, which has a population of about 7,000 people (counting those in the principal town and its surrounding communities) is served by basic, intermediate, and secondary schools, a church with a resident priest, two *practicantes,*[6] mail service, a regular truck service, and a telegraph line. The water supply, provided through a collective system, is hand-drawn from open wells. The church's marriage books date from 1751, and baptismal records go back to 1753. No electricity is supplied.

Typically, many Turco and Toledo residents have permanent houses within the village proper and small lean-to shelters on their farmland. This is especially true of people whose fields are far removed from the community concerned. As is customary at the season when our examinations were conducted, a substantial number of Turco and Toledo residents were engaged in the potato harvest and were not actually present in their home villages.

The inhabitants of both these communities are socioculturally heterogeneous. Some are non-Aymará (that is, they claim only Spanish or other European antecedents), and many are Aymará (*5*), but still more are considered "*mestizos*" or "*cholos.*" The latter expressions are used indiscriminately to characterize not only individuals of mixed Indian and non-Indian ancestry, but often also Aymará who are socially mobile upward and who have adopted Spanish customs, conventions, and names. Thus, while the categories Aymará and non-Aymará have some biological meaning, the terms *mestizo* and *cholo* provide less certain identification. What data are available on inherited biochemical and immunological markers suggest that the *mestizos* are appreciably more Aymará than non-Aymará.

Our assessment of an individual's origins was made on essentially sociological grounds, being based entirely on the surnames of the subject's parents—and where possible of the grandparents. The algorithm employed for this purpose has been described elsewhere (*4, 6*). It tends to underrepresent the Aymará, a number of whom will be classified as *mestizos*—either if their normal array of names is incomplete, or if (as is frequent in Bolivia) they consciously adopt Spanish names to obscure their origins.

Assessment of Disease and Disability

Disease and disability among the Aymará living in these communities was assessed on the basis of a detailed medical history and examination. The work included completion of the Rose and Blackburn (*7*) cardiovascular questionnaire, a physical examination, a cardiac evaluation and electrocardiogram, pulmonary function tests, an oral cavity and dental examination, visual acuity and color vision tests, a fine motor control test (tapping), anthropometric measurements, and analysis of a venous blood specimen. In addition, demographic, residential, and reproductive histories were compiled for each examined person. Schull and Rothhammer (*4*) provide a complete description of the details of each examination, test, and questionnaire, and of the equipment used in the study. Selection of subjects to be examined was based on their willingness to participate. An open invitation was made to all village residents at

[6]Members of the police force who have had paramedical training.

meetings with town leaders, schoolteachers, and church officials.

This presentation describes the results of the 429 physical and dental examinations completed in the two villages (Turco and Toledo) during the month of April 1975. The examinations were performed by a multinational team—a cardiologist, a dentist, and several other physicians, technicians, and interviewers from Bolivia, Chile, and the United States.

A number of study population characteristics are indicated by the data in Tables 1 and 2. As Table 1 shows, nearly 92 per cent of the examinees had resided all of their lives in the *altiplano*. In addition, it can be seen that almost equal numbers of males and females (216 versus 213) and of children and adults (214 versus 215) were examined. These numbers reflect the presence of schools and the temporary absence of adults who were out of town taking part in the potato harvest. Table 2 shows the number of children in nuclear families and the number of respective parents also examined.

After a review of body systems—with specific emphasis on the lungs—by the general physician, the cardiologist made a detailed cardiac examination, took two sitting blood pressures, and obtained an electrocardiogram. The blood pressures were taken with the examinee in the sitting position—using a mercury sphygmomanometer very near the end of the physical examination. The measurements were normally made on the right arm, except where extenuating circumstances (e.g., injury to this arm) existed. The systolic pressure was taken to be the pressure at which sound was

Table 1. Distribution of the Bolivian (Turco and Toledo) examinees by age, sex, ethnicity, and percentage of time spent living at the place of residence.

Time spent in place of residence and ethnicity	Male		Female		Total		
	Child[a]	Adult[b]	Child	Adult	Child	Adult	Total
Ethnic categories of those spending all their lives (100%) in the area of residence:							
Aymará	39	41	33	53	72	94	166
Mestizo	73	41	63	42	136	83	219
Non-Aymará	3	2	1	2	4	4	8
Total	115	84	97	97	212	181	393
Ethnic categories of those spending less than 90% of their lives in the area of residence:							
Aymará	0	5	1	7	1	12	13
Mestizo	0	4	1	9	1	13	14
Non-Aymará	0	0	0	1	0	1	1
Total	0	9	2	17	2	26	28
Subjects spending over 90 but less than 100% of their lives in the area of residence:	0	8	0	0	0	8	8
Totals	115	101	99	114	214	215	429
	216		213		429		429

[a]Child = subject less than 15 years of age.
[b]Adult = subject 15 years of age or more.

Table 2. Data on size of families of Bolivian examinees.

Number of offspring examined from the family involved	No. of parents examined		One parent examined		Both parents examined		Total	
	No. of families[a]	No. of subjects	No. of families	No. of subjects	No. of families	No. of subjects	No. of families	No. of subjects
1	160	160	25	50	10	30	195	240
2	8	16	12	36	13	52	33	104
3	1	15	7	24	14	55	22	94
4	1	8	3	15	8	42	12	65
5	0	5	0	0	6	35	6	40
6	0	6	2	7	2	16	4	29
Total	170	210	49	132	53	230	272	572[b]

[a]Number of families represents single nuclear families.
[b]This number exceeds the total number of individuals examined because the 143 parents who were examined were counted twice, namely, once as parents and again as offspring.

first perceived; the fourth- and fifth-phase diastolic pressures, both of which were recorded if heard, were taken to be those pressures at which the sounds ceased to have a tapping quality and became fully muffled (in the first instance) or disappeared completely (in the second). Diastolic pressures cited in the data presented here are always fourth-phase diastolic pressures.

Diagnostic impressions were recorded for each individual and then coded according to the *International Classification of Diseases* (*8*). In addition, hemoglobin and hematocrit analyses were coded for anemia, and blood pressure readings were coded for hypertension. The criterion for coding anemia was a hemoglobin less than or equal to 12.00 g for males or less than or equal to 10.00 g for females; the hemoglobin was determined by using a spectrophotometer to examine an unprecipitated heparinized venous specimen. Acute hypertension was coded if a person 15 years of age or older presented a systolic reading equalling or exceeding 160 mm of mercury or a diastolic pressure equalling or exceeding 95 mm of mercury. Borderline hypertension was coded if an individual had a systolic reading of 140 to 159 mm or a diastolic reading of 90 to 94 mm. Tables 4 and 5 present the distribution of diseases and disorders diagnosed in the study population, grouped according to ethnic identity and the proportion of lifetime spent at the current area of residence. Electrocardiograms were read by staff members of the University of Minnesota's Laboratory of Physiological Hygiene.

Findings

Some 145 different ICDA[7] codable diseases or "symptoms and ill-defined conditions" were encountered among the 429 individuals studied. Most of these involved no more than a few individuals; hence diagnosis-specific comparisons between the two communities, or between this and other studies of ill health among indigenes of the *altiplano*, would be statistically meaningless. We have therefore grouped our findings into broader diagnostic categories. In addition, however, the paragraphs that follow will call attention to the most frequently encountered problems in each category—besides those specific diagnoses mentioned in Tables 3 and 4.

1) Infective and Parasitic Diseases

The most commonly seen infective dis-

[7]*International Classification of Diseases Adapted for Use in the United States* (*8*).

Table 3. Distribution of diseases and disorders in members of the population of the Department of Oruro, spending their whole lives (100 per cent) in the area of residence, by sex and ethnicity.

Disease category	ICDA code	Aymará				Mestizo				Non-Aymará			
		Male		Female		Male		Female		Male		Female	
		C[a]	A[b]	C	A	C	A	C	A	C	A	C	A
Infective and parasitic	000-136	5	5	3	9	8	5	5	7	–	–	–	1
Neoplasms	140-239	–	2	–	1	–	1	–	–	–	–	–	–
Malignant	*140-209*	–	*1*	–	*1*	–	–	–	–	–	–	–	–
Benign or unspecified	*210-239*	–	*1*	–	–	–	*1*	–	–	–	–	–	–
Endocrine, nutritional, metabolic	240-279	–	–	1	2	–	–	–	1	–	–	–	–
Diabetes mellitus	*250*	–	–	–	–	–	–	–	*1*	–	–	–	–
Blood, blood forming organs	280-289	1	–	–	–	–	1	1	4		–	–	–
Mental disorders	290-315	–	–	–	–	–	–	–	–	–	–	–	–
Nervous system, sense organs	320-389	1	15	–	10	10	17	3	14	–	1	–	1
Nervous system	*320-358*	*1*	2	–	*1*	–	*1*	–	–	–	–	–	–
Eye	*360-379*	–	5	–	*1*	*5*	*12*	*1*	*5*	–	*1*	–	–
Ear, mastoid process	*380-389*	–	*8*	–	*8*	*5*	*4*	2	*9*	–	–	–	*1*
Circulatory system	390-458	–	12	2	9	–	9	4	7	–	–	–	–
Acute hypertension (≥ 160/95)	*401*	–	*1*	–	*2*	–	–	–	–	–	–	–	–
Borderline hypertension(≥ 140/90)	*401.0*	–	–	–	*4*	–	*2*	*1*	*3*	–	–	–	–
Acute myocardial infarction	*410*	–	–	–	–	–	–	–	–	–	–	–	–
Other ischemic heart disease	*411-414*	–	*1*	–	*1*	–	*2*	–	–	–	–	–	–
All other heart disease	*390-429*	*7*	*2*	*1*	–	*3*	*3*	*4*	–	–	–	–	
Cerebrovascular disease	*430-438*	–	–	–	–	–	–	–	–	–	–	–	–
Respiratory system	460-519	11	4	3	7	9	3	5	1	–	–	–	–
Acute resp. infect. except influenza, tonsilitis, and sinusitis	*460-466*	*11*	*1*	*3*	*5*	*9*	*2*	*4*	*1*	–	–	–	–
Pneumonia	*480-486*	–	–	–	–	–	–	–	–	–	–	–	–
Acute tonsilitis, hypertrophy of tonsils and adenoids	*463,500*	–	–	–	–	–	*1*	*1*	–	–	–	–	–
Digestive system	520-577	–	9	–	8	1	6	4	5	–	1	–	–
Inguinal hernia	*550,552*	–	*2*	–	–	–	*3*	–	–	–	–	–	–
Cholelithiasis, Cholecystitis	*574,575*	–	–	–	2	–	*2*	–	*3*	–	–	–	
Genitourinary system	580-629	–	–	–	4	–	1	–	8	–	–	–	–
Hyperplasia of prostate	*600*	–	–	–	–	–	–	–	–	–	–	–	–
Disorders of menstruation	*626*	–	–	–	*3*	–	–	–	–	–	–	–	–
Complications of pregnancy	630-678	–	–	–	2	–	–	–	–	–	–	–	–
Skin, subcutaneous tissue	680-709	1	8	–	16	1	10	1	8	–	1	–	1
Musculoskeletal, connective tissue	710-738	1	3	1	4	3	9	1	4	–	–	–	1
Arthritis, all forms	*710-718*	–	*1*	–	2	–	*3*	–	2	–	–	–	*1*
Congenital anomalies	740-759	3	2	–	–	7	2	1	2	–	–	–	–
Symptoms, ill-defined conditions	780-796	–	9	–	6	6	9	2	4	–	1	–	–
Accidents	800-999	–	–	–	–	2	2	–	–	–	–	–	–
Conditions, exams w/o sickness	793,Y00-Y13	–	–	–	4	–	–	–	8	–	–	–	–
Total, all diagnoses		23	69	10	82	47	75	27	73	–	4	–	4
People examined		*39*	*41*	*33*	*53*	*73*	*41*	*63*	*42*	*3*	*2*	*1*	*2*

[a] C = children
[b] A = adults
– = 0

orders were tuberculosis (14 cases) and whooping cough (4 cases). This number of tuberculosis cases did not come as a surprise. Other studies (*9*) have obtained positive sputums from about 2 per cent of the individuals tested in *altiplano* communities, and have reported that by age 20 almost 90 per cent of the people will be tuberculin reactors. The most prevalent parasitic disorder found was scabies (26 cases); however, no stool examinations were performed, and experience gained elsewhere suggests that both *Ascaris* and *Trichuris* are common—indeed, that they are present in some 30 per cent of the people in this region of Bolivia (*9*, Table 44).

2) *Neoplasms*

Only two malignant tumors were recognized clinically (it was impracticable to obtain histologic confirmation). One of these involved a salivary gland and the other the skin.

3) *Blood and Blood-forming Organs*

Anemia was the only disorder of the blood

Table 4. Distribution of disease and disorders in members of the population of the Department of Oruro, spending less than 90 per cent of their lives in the area of residence, by sex and ethnicity.

Disease category	ICDA code	Aymará				Mestizo				Non-Aymará			
		Male		Female		Male		Female		Male		Female	
		C[a]	A[b]	C	A	C	A	C	A	C	A	C	A
Infective and parasitic	000-136	–	1	–	3	–	–	–	–	–	–	–	–
Neoplasms	140-239	–	–	–	–	–	–	–	–	–	–	–	–
Malignant	*140-209*	–	–	–	–	–	–	–	–	–	–	–	–
Benign or unspecified	*210-239*	–	–	–	–	–	–	–	–	–	–	–	–
Endocrine, nutritional, metabolic	240-279	–	–	–	–	–	–	–	–	–	–	–	–
Diabetes mellitus	*250*	–	–	–	–	–	–	–	–	–	–	–	–
Blood, blood forming organs	280-289	–	–	–	–	–	–	–	–	–	–	–	–
Mental disorders	290-315	–	–	–	–	–	–	–	1	–	–	–	–
Nervous system, sense organs	320-389	–	2	–	4	–	1	–	2	–	–	–	–
Nervous system	*320-358*	–	–	–	–	–	–	–	–	–	–	–	–
Eye	*360-379*	–	*1*	–	*1*	–	*1*	–	2	–	–	–	–
Ear, mastoid process	*380-389*	–	*1*	–	3	–	–	–	–	–	–	–	–
Circulatory system	390-458	–	1	–	2	–	1	–	3	–	–	–	–
Acute hypertension (≥ 160/95)	*401*	–	–	–	–	–	–	–	–	–	–	–	–
Borderline hypertension (≥ 140/90)	*401 0*	–	*1*	–	–	–	–	–	–	–	–	–	–
Acute myocardial infarction	*410*	–	–	–	–	–	–	–	–	–	–	–	–
Other ischemic heart disease	*411-414*	–	–	–	–	–	*1*	–	*1*	–	–	–	–
All other heart disease	*390-429*	–	–	–	*1*	–	–	–	2	–	–	–	–
Cerebrovascular disease	*430-438*	–	–	–	–	–	–	–	–	–	–	–	–
Respiratory system	460-519	–	1	–	–	–	2	–	2	–	–	–	–
Acute resp. infect. except influenza, tonsillitis, and sinusitis	*460-466*	–	*1*	–	–	–	*2*	–	–	–	–	–	–
Pneumonia	*480-486*	–	–	–	–	–	–	–	–	–	–	–	–
Acute tonsillitis, hypertrophy of tonsils and adenoids	*463,500*	–	–	–	–	–	–	–	–	–	–	–	–
Digestive system	520-577	–	3	–	3	–	–	–	2	–	–	–	1
Inguinal hernia	*550,552*	–	–	–	–	–	–	–	–	–	–	–	–
Cholelithiasis, cholecystitis	*574,575*	–	*1*	–	2	–	–	–	*1*	–	–	–	–
Genitourinary system	580-629	–	–	–	2	–	–	–	3	–	–	–	–
Urinary system	*580-599*	–	–	–	–	–	–	–	–	–	–	–	–
Hyperplasia of prostate	*600*	–	–	–	–	–	–	–	–	–	–	–	–
Disorders of menstruation	*626*	–	–	–	–	–	–	–	*1*	–	–	–	–
Complications of pregnancy	630-678	–	–	–	–	–	–	–	–	–	–	–	–
Skin, subcutaneous tissue	680-709	–	3	–	4	–	1	–	2	–	–	–	1
Musculoskeletal, connective tissue	710-738	–	–	–	1	–	–	–	–	–	–	–	–
Arthritis, all forms	*710-718*	–	–	–	*1*	–	–	–	–	–	–	–	–
Congenital anomalies	740-759	–	–	–	–	–	1	–	–	–	–	–	1
Symptoms, ill-defined conditions	780-796	–	–	–	1	–	–	–	2	–	–	–	–
Accidents	800-999	–	–	–	1	–	–	–	–	–	–	–	–
Conditions, exams w/o sickness	793,Y00-Y13	–	–	–	1	–	–	–	–	–	–	–	–
Total, all diagnoses		–	11	–	22	–	6	–	17	–	–	–	3
People examined		–	*5*	*1*	*7*	–	*4*	*1*	*9*	–	–	–	*1*

[a] C = children
[b] A = adults
– = 0

or blood-forming organs that was recognized. Most individuals designated as being anemic were women in the child-bearing years. As previously stated, the diagnosis of anemia was based solely on the observed hemoglobin concentration. We believe this diagnosis largely reflects an iron deficiency of nutritional origin.

4) *The Nervous System and Sense Organs*

The most frequently observed nervous system disorders were those involving the eye, the ear, or both. Common among the ophthalmic problems were pterygium, conjunctivitis, and inflammation of the lacrimal tract. Goldsmith et al. (*10*) found these complaints to be common in the *sierra* and *altiplano* of Chile as well; they can be readily ascribed either to the dust and persistent wind that characterize these elevations, or else to neglect. Otitis media was common, and impaired hearing was recorded in one or both ears of 33 individuals. Presumably, much of this impairment was secondary to chronic ear infections.

5) *The Circulatory System*

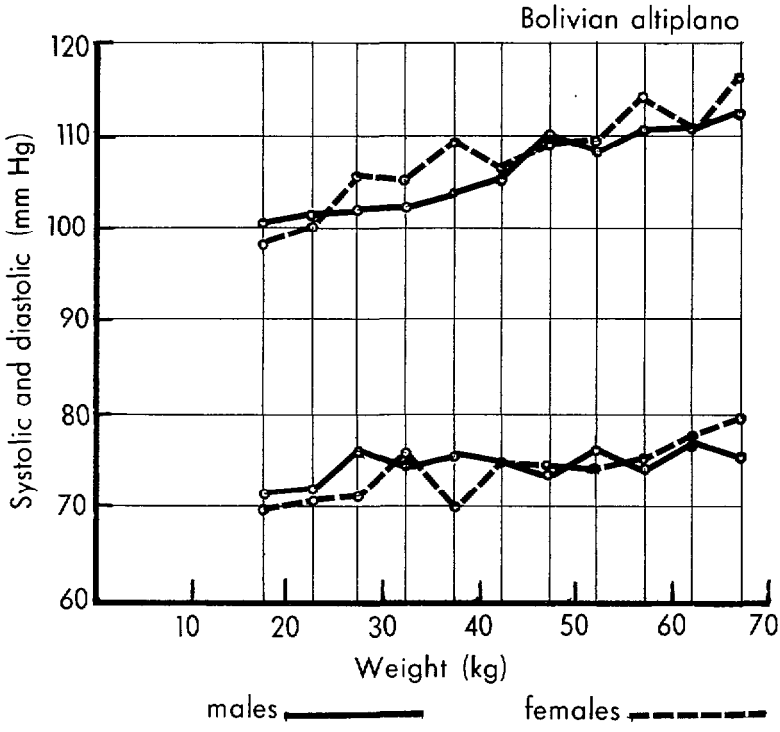
Three of some 177 adults who claimed to

Figure 1. Distribution of systolic blood pressures (above) and diastolic blood pressures (below) among male and female residents of Turco and Toledo, by age at the time of examination.

have lived at no other elevation than that of the *altiplano* were hypertensive by conventional standards, and another nine had either systolic or diastolic pressures sufficiently high to be labeled "borderline." These case frequencies are higher than has often been assumed, but they are only half as high as the frequencies we encountered in the *sierra* and *altiplano* of Chile (*6*). The numbers are small, of course, and the differences between these frequencies and others observed are not statistically significant. If one considered the ages of the adults (119 were 30-69 years of age) and applied the age-specific frequencies of hypertension that prevail in the white population of the United States, however, one would have expected 14 hypertensive individuals.

Figures 1 and 2 show the distribution of systolic and diastolic blood pressures of males and females by age (Figure 1) and weight (Figure 2). Our measurements in the two communities have been pooled, since there was only a trivial difference in the means obtained for Turco and Toledo subjects. (Table 5). No clear dependence on age could be detected among either males or females; however, weight was clearly associated with blood pressure. Systolic pressure, in particular, increased linearly with weight, doing so almost equally among males and among females. Indeed, weight alone accounted for about 22 per cent of the variation observed in the systolic pressures of different individuals. It warrants mention that "weight" here is virtually synonymous with lean body weight; few of the individuals examined fell within the upper twentieth percentile of the weight for height ratio based upon United States standards. In general, this

Figure 2. Distribution of systolic blood pressures (above) and diastolic blood pressures (below) among male and female residents of Turco and Toledo, by weight in kg at the time of examination.



blood pressure rise with increasing weight in Bolivia is in accord with what we have previously reported for Chile (*11*). That is, systolic pressure increased about 0.3 mm/kg of weight in both sexes in Bolivia and about 0.4 mm/kg in Chile.

Among other cardiovascular problems, the most common were abnormalities of rhythm-ventricular contractions (8 cases), ventricular fibrillation (1 case), and right bundle branch block (2 cases). Right ventricular hypertrophy and right bundle

Table 5. Average ages, weights, and blood pressures of 320 subjects from whom both weight and blood pressure measurements were obtained.

	Turco (N = 218)		Toledo (N = 102)		Total (N = 320)	
	Males (112)	Females (106)	Males (47)	Females (55)	Males (159)	Females (161)
Mean age (in years)	28.9	27.4	28.6	26.5	28.8	27.1
Mean weight (in kg)	46.9	43.7	43.1	43.2	45.8	43.5
Mean systolic pressure (in mm Hg)	107.8	107.9	107.7	109.8	107.8	108.5
Mean fourth-phase diastolic pressure (in mm Hg)	74.9	74.2	73.6	73.3	74.5	73.9

branch block (complete or incomplete) are commonly seen among high-altitude indigenes (*12*). Continuous cardiac monitoring in this population has revealed bradycardia to be even more frequent than has generally been surmised from clinical examinations (*13*).

It is of interest, when one considers the socioeconomic level of this population, that we observed none of the cardiac sequellae commonly associated with rheumatic fever.

6) The Digestive System

Widespread dental caries (*14*), a nonspecific gastritis, and inguinal hernia accounted for most of the digestive system problems found.

7) The Genitourinary System

Three disorders of the genitourinary system were prominent. These were abnormalities of menstruation (5 cases), salpingitis (4 cases), and leukorrhea (6 cases).

8) The Skin and Subcutaneous Tissue

Cicatrices (55 cases) and keloids (2 cases) accounted for virtually all of our findings involving the skin and subcutaneous tissue.

9) The Musculoskeletal and Connective Tissues

Rheumatoid arthritis was relatively common in the older age groups, and kyphosis and deformities of the extremities were seen in subjects of all ages.

10) Congenital Anomalies

The most frequently observed congenital anomalies were undescended testis (5 cases), pigeon chest (6 cases), and congenital dislocation of the hip (2 cases). It should perhaps be mentioned here that we saw only one case of harelip (with or without cleft palate) during some 2,500 examinations performed in Bolivia and Chile (*5*), and that the child affected failed to survive a year.

11) Other Symptoms and Ill-defined Conditions

Palpation frequently revealed enlarged lymph glands (15 cases), and complaints referable to the genitourinary system (5 cases) and the upper gastrointestinal tract (5 cases) were common.

Concluding Remarks

How representative, now, are these findings—not only of disease and disability in these specific communities but also in other towns and villages in western Bolivia? Intuitively, one tends to presume that the acutely ill, the blind, the deaf, and the halt are underrepresented, for they may have been physically unable to present themselves at the site of the examinations.

While this presumption is difficult to challenge, it does fail to reckon with the importance ascribed to medical attention in areas such as Turco, for example, where it is not routinely available. We therefore suspect, but cannot clearly establish, that the handicapped and acutely ill that we did not see were few in number. Two lines of evidence support this notion. First, at the time of the examinations the town council member involved in health and sanitary activities was aware of no one who was physically unable to come to the small clinic where the examinations took place. Second, Turco's demography and socioeconomic characteristics are typical or countless small, semi-isolated western Bolivian villages. We presume, therefore, that its burden of disease and disability is similar to that prevailing in most such villages. Similar remarks can be made with regard

to Toledo, save that it typifies a somewhat smaller group of larger communities. It therefore seems relevant that our findings in these two communities are very similar to those reported by the United States A.I.D. Mission to Bolivia (*15*).

ACKNOWLEDGMENTS

Studies as large and complex as those to which this set of observations belongs, conducted under circumstances as alien to most of us as the conditions existing at the higher Andean altitudes, patently owe whatever measure of success they achieve to many individuals. This investigation is no exception. We are indebted to numerous people and institutions at the local and national levels in Bolivia, especially to Colonel Antonio Ovando of the Development Corporation of Oruro, to Fathers Emery Mulaire and Santiago Monaste, to Gilberto Pauwels, Juan Capurate, Teofilo Ayma, and to each member of the field team. We are also indebted to Dr. Merry Makela, Susan Seybold, Paula Carlock, and Richard Allen, without whose help the data reported here might not be available for analysis. Finally, we welcome this opportunity to express our gratitude to the residents of Toledo and Turco, who in patience and good humor tolerated our questions, pokings, and proddings.

SUMMARY

Examination of 429 residents of two *altiplano* communities in western Bolivia's Oruro Department disclosed a number of hypertensive individuals, generally thought to be rare or nonexistent at these altitudes, and a clear correlation between blood pressure and weight. This correlation was surprisingly similar to one previously described in the north Chilean Province of Arica, where high-altitude weight gains produced essentially the same blood pressure increases seen in coastal residents. Mean blood pressures were found to be lower in the Bolivian villages than commonly reported elsewhere, but the inhabitants of these villages were both smaller and lighter. These effects (smaller average size and weight) are undoubtedly ascribable to marginal nutrition as well as to the subjects' genetic background; obesity was rare, but so too was clinically frank evidence of malnourishment.

Most of the other disorders reported here seem to directly reflect the rigors of life on the *altiplano*. Respiratory diseases were common, and middle ear infections and their sequellae were often seen; diseases of the skin reflected the diminished moisture and increased cold; and ophthalmic problems attested to the ravages of dust, persistent wind, and neglect.

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STUDY GROUP ON NERVOUS DISEASES*

Experts in the field of neuroscience and neurology from 12 countries met at WHO Headquarters in Geneva, 1-4 October 1979, to study disorders of the peripheral nervous system. They reviewed the multitude of diseases that affect human nerves and made recommendations concerning prevention, treatment, and research. Attention was called to the fact that peripheral neuropathies deserve special attention because of their widespread incidence in both industrialized and developing countries.

Infectious diseases of nerves caused by bacteria, viruses, and environmental toxins were the subjects of discussion, as were autoimmune disorders such as the Guillain-Barré syndrome—of particular concern in developing countries—and diabetic neuropathy and its socioeconomic implications, and other diseases caused by undernutrition in developing countries and malnutrition in industrialized societies.

*WHO press release, 8 October 1979.