Identification of Predictive Factors of BMI and High Risk Hypertension in Rural Nicaraguan Community

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Abstract

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Background: Cardiovascular disease is an increasing concern in Nicaragua and a growing number of organizations are working to confront it. Health needs assessments focusing on cardiovascular disease are a recommended first step in community-level work. In 2012, two non-governmental organizations, Salud Juntos and AMOS Health, collaborated to undertake a health needs assessment in a rural northern Nicaraguan community.

Methods: Collaborators used adapted WHO STEPS and CDC BRFSS questions to create a survey tool to help identify health behaviors which may contribute to overweight/obesity or high risk hypertension in the community. Local community health workers conducted the survey in the small community and attempted universal sample of the adult population, ultimately reaching 91/114 adults. Anthropometric and blood pressure measures were included. Descriptive statistics and regression modeling were used to analyze the data.

Results: Descriptive data revealed a community with low smoking and drinking, lack of screening for diabetes, and notable consumption of fried processed foods and sugary drinks. Males were also found to be, on average, more physically active than women. Women were found to have a three-fold higher prevalence of overweight and obesity than men. 20% of interviewees were found to be hypertensive, the majority of whom were untreated and previously undiagnosed. Our regression based analysis did enable us to identify any health behaviors as associated with the outcomes of BMI or high risk hypertension.

Conclusion: We felt that the characterization chronic disease burden in the community through our survey methods and analysis yielded a useful starting point for intervention planning and implementation – likely focusing on hypertension treatment, and physical activity in women.

Introduction

Cardiovascular disease is a present and increasing concern in Nicaragua and a growing number of health organizations are attempting to confront it. In Nicaragua, two of the top six causes of premature death are ischemic heart disease and stroke, respectively representing 7.2% and 4.5% of all deaths.[1] Additionally, three of the four leading risk factors for overall disease burden are associated with cardiovascular disease: poor nutrition (including excessive calorie intake), high blood pressure, and high body mass index. [2] In Nicaragua, it is estimated that 34% of the population has elevated blood pressure, 33% is overweight, and 22% is obese.[3,4] In certain Nicaraguan populations it has been found that the majority of people with hypertension are undiagnosed[5], and in rural areas those with the diagnosis are often poorly controlled.[6] Recent changes in diet, daily activities, livelihood, and extended life expectancy are all partial explanations for this large burden of chronic cardiovascular disease in Nicaragua. It is clear that there are limited opportunities for individuals to access a consistent source of screening, care and medications to manage chronic conditions such as hypertension in rural settings.[7]

The participation of foreign and domestic non-governmental and community organizations (NGOs) is a consistent feature of the health landscape in Central America. As of 2007, there were 90 NGOs, running 49 health centers, registered with the Nicaraguan Ministry of Health.[7] These NGOs have traditionally worked to provide acute medical and surgical care from visiting physicians, ongoing care in rural health centers, and partnerships on programming for infectious diseases and maternal and child health.[7] As in other countries, the focus of many health-related NGOs in Nicaragua is switching towards chronic cardiovascular diseases. As such, more evidence based methods are required to assure that implementations appropriate to local needs and context are carried out, and that these implementations are successful and sustainable.[8] It has become a commonly encouraged practice to conduct a relevant community survey or health needs assessment (HNA) as a preliminary, or baseline, step in the development of successful community health interventions.[8,9] Several approaches have been

favored: interviews, self-administered questionnaires, community rapid appraisals, and epidemiologic rapid assessments. Most of these approaches lead to quantitative evaluation, as only interview and community rapid appraisal methods have the potential of yielding qualitative data.[9] Some survey based approaches, including the World Health Organization's STEPwise Approach to Surveillance of Chronic Disease and Risk Factors (STEPS), have been used on a larger scale in resource poor settings.[10, 11] Though these larger survey tools are indeed helpful in making regional and country-level policy decisions, there is little in the literature on the use of this kind of tool as a HNA specific to chronic cardiovascular disease in smaller, low-resource communities.[11] There is further impetus to evaluate the appropriateness of these HNA methods in small, diverse communities in the developing world as substantiated methods are equally needed in domestically as the United States begins mandating increased HNAs in keeping with the Accountable Care Act. [12]

We conducted a survey and ensuing analysis as a collaboration between two community health focused NGOs that work in Central America – AMOS Health and Salud Juntos. AMOS is a nonprofit based in Nicaragua with a network of 27 rural community clinics run and managed by local community health workers (CHW) using the strategy of community based primary health care. AMOS has historically focused its health programming on maternal and infant health, under-nutrition, and health literacy. Salud Juntos has been working in the Department of Yoro, Honduras since 2008 to develop sustainable public health services that prevent, manage, and treat chronic conditions. Salud Juntos is made up of collaborators from the United States and Honduras – including health professionals, community leaders, CHWs, educators, and students. Following the Chronic Care Model,[13] Salud Juntos currently has community programming that is premised around CHWs which address hypertension, diabetes, dental health, nutrition, and asthma. AMOS approached Salud Juntos in 2011 to enlist help in developing hypertension programming.

A survey project was undertaken with the intent of having it act as a foundational step in AMOS's development of a systematic approach to chronic disease prevention and treatment in the rural communities they serve. With the help of Salud Juntos, AMOS structured a survey to be used in its communities to ascertain risk factors, health behaviors, and disease burden for high blood pressure and overweight/obesity. AMOS has thus far been able to carry out this survey in one community. The evaluation of the results from this survey was executed with the immediate objective of developing recommendations for implementation of chronic disease programming in the communities where AMOS works. Specifically, the first aim of this analysis was to characterize health behaviors and cardiovascular risk factors of the survey population including prevalence of uncontrolled blood pressure, high-risk hypertension, and overweight/obesity. The second aim of this analysis was to identify behavioral predictors of increased BMI within the population. We hypothesized that the behavioral risk factors relating to poor diet, minimal exercise, and increased alcohol intake captured in the survey would act as predictors for increased BMI. The third and final aim of this analysis was to identify predictors of high-risk hypertension.[14] We hypothesized that variables representing diet, exercise, tobacco use, and alcohol intake would act as predictors for increased likelihood of high-risk hypertension. Finally, and more generally, we comment on how useful out quantitative survey and regression analysis methods were in identifying areas for interventions for the small Nicaraguan community.

Methods

Setting and Population

The survey was conducted in a small, rural town in the northeastern province of Chinandega, Nicaragua where AMOS has been working for more than five years. This community was selected by AMOS as the first to be surveyed as it was felt that houses were situated relatively close to each other and the local CHWs were very competent. An interview survey method was selected by collaborators as

it was felt that it would provide a) easily analyzable and interpretable data, b) a near universal assessment of the community given the small population, and c) an evaluation strategy which could be easily carried out by local staff and CHWs. A universal adult sample from the community was the intended population. In order to meet criteria to be surveyed, subjects had to be residents of the community and 25 years of age or older. In the community there were 114 inhabitants who met these criteria.

Measures

The data being used in this study includes the responses from a modified STEPS survey[10] which borrows physical activity data from the Center for Disease Control and Prevention's Behavior Risk Factor Surveillance System.[15] Questions regarding sugary drinks and processed food were also included. Our survey definition of sugary drinks included self-reported consumption of juice, soda/pop/cola, and sugar-added drinks like coffee and tea. We defined processed snacks as foods which come in commercial packaging and need no further preparation. Development of the survey questionnaire was performed by representatives of AMOS and Salud Juntos, and CHWs from the communities that AMOS serves in the Chinandega region. This form was prospectively edited by AMOS Health representatives before testing the tool in the community. The survey tool was tested in three cycles using the local CHWs to administer the surveys while AMOS Health and Salud Juntos representatives observed. Edits to the survey form were made based upon recommendations of the CHWs and observed areas for improvements.

AMOS employed a team of CHWs to do a house-to-house survey in the community using the modified STEPS survey in September 2012. All willing residents who were at home and met survey criteria were interviewed and had measurements taken. Data collection was overseen by research-trained AMOS staff. Height and weight were measured in accordance with STEPS criteria using a portable measuring tape and scale.[10] Three separate blood pressure readings were taken at the initial

interview using an automated OMROM BP760 7 Series cuffs. If one of the three readings at this first sitting was found to be ≥140/90 mmHg then the subject would be revisited by a CHW later that day, or the following day, and an additional three readings would be taken. Subjects would be revisited until two separate sittings yielded two readings of ≥140/90 mmHg. No more than five measurement sittings were performed on any given subject. Also, a household number was recorded for each subject using the system for house numbering that AMOS had implemented in previous investigations in the local community. This household number was entered in the survey form by the AMOS associated interviewer familiar with the numbering system at the time of survey. The surveys were entered into a de-identified Microsoft Excel 2010 file by AMOS administrative staff and this file was sent to members of the University of Washington evaluation team.

In order to compensate for missing data, which we concluded to be missing at random, we used multiple imputations, imputing 10-times over to create a second dataset appropriate for our statistical analyses.

Statistical Analysis

A cross-sectional analysis was performed using the survey dataset from community residents. The analysis of this secondary data was deemed to be of exempt status by the University of Washington Human Subjects division. Descriptive statistics were generated using the non-imputed dataset. Physical activity, which was reported as a set of continuous variables, was converted to categorical variables for analysis. BRFSS designations were applied to the weekly physical activity time, enabling for categorization of physical activity by subject as adequate, inadequate, or inactive. Recommended physical activity was defined as moderate activity for a minimum of 30 minutes a day, five or more times a week, or vigorous activity for a minimum of twenty minutes greater than or equal to three days per week. Inactivity was defined as fewer than 10 minutes of physical activity total per week and insufficient physical activity was defined as all levels of activity which fall between “recommended” and “inactive.”

We also created a variable for the proportion of weekly physical activity time coming from work-related activity. We chose to define all recorded activity reported as moderate activity due to lack of certainty regarding nature of reported physical activity. Drinkers were classified as current binge drinkers, current non-binge drinkers, or current non-drinkers. Binge drinking is defined as greater than four drinks in a sitting for women and greater than five for men.

The survey data enabled us to categorize hypertension in several ways. Using our blood pressure measurement data we categorized subjects as being currently uncontrolled if the average of the second and third blood pressure readings for two or more sittings is ≥140/90 mmHg. We classified subjects as being hypertensive if they were currently receiving treatment for hypertension at the time of survey or if they were currently uncontrolled. Finally, we identified high-risk people with hypertension, defined as those subjects that meet the definition or hypertensive and meet one of the following criteria – known diabetes, ≥65 years old, BMI ≥ 25 kg/m^2, current tobacco user, blood pressure ≥160/100 mmHg.[14]

We performed two regression-based analyses to identify intervention-appropriate risk factors for a) overweight/obesity, or b) high-risk hypertension. For both analyses we constructed regression models looking at exposure variables related to drinking, sugary drink consumption, processed food consumption, and physical activity. Note that smoking was also tested as a predictor in our model for high risk hypertension but not for BMI as the literature indicates a positive relationship between smoking and hypertension, but not overweight/obesity.[16] Both models used age and sex as control variables and also clustered the data based upon household number to account for potential lack of independence of individual behaviors caused by household level norms. Our analysis of predictors for overweight/obesity utilized a linear regression model with continuous BMI as the outcome. Our analysis for high-risk hypertension uses our high-risk hypertensive variable as the outcome in a logistic regression model. We also ran secondary analyses of our previous regressions, stratifying them

separately by sex and marital status in order to check for effect modification and restricting these analyses to individuals under 70 years old in order to control for age.

Results

A total of 91 community members from 46 households completed the modified STEPS survey. Descriptive statistics can be found in Table 1, stratified by sex. We found that respondents were equally split by sex, were spread evenly across adult ages (mean 46 years), were largely married/partnered (76%), of healthy weight, non-smokers, non-drinkers, met recommended physical activity definition, ate processed snacks, and drank roughly two sugar sweetened beverages daily. The percentage of weekly physical activity hours coming from work-related activity was lower for women (23%) than for men (79%). Males were also more physically active than females, and more likely to be current drinkers and smokers. Overweight and obesity also differed significantly by sex, with women almost three times more likely to be overweight or obese compared to men. Females were more commonly under current treatment for hypertension, and were more likely to have both their blood pressure and blood sugars checked in the past. Over 54% of all subjects had never received a blood pressure check previously, and 77% had never had their blood sugar tested.

Hypertension statistics showed that a sizable burden existed within the community. The majority of subjects previously diagnosed with hypertension had previously received their medications locally from the Ministry of Health system, however only 9 out of the 91 subjects were currently on hypertension therapy. The mean blood pressure for the sample population across sittings was 118.44/75.97 (SD 20.02/11.76). There were 12 cases of uncontrolled hypertension identified through survey measurements, 3 of which were ≥160/100. Our evaluation definition defined 18 members of the survey sample as hypertensive, which was 20% of the total population. Of these identified hypertensive subjects, 11 of them were 65+ years-old, and all of them were high-risk.

Our final linear and logistic regression models for the testing of predictors for BMI and high risk hypertension yielded no clear identification of predictors. Upon running all variables individually we found no significant trends according to p-values and 95% confidence intervals (Table 2). Additionally, the insignificant statistical relationships resulting from our regressions went in the direction opposite of what we hypothesized. Our secondary stratified regression analysis for identification of predictors of both BMI and high risk hypertension similarly did not identify any of our variables as potential predictors. Despite not showing any significant associations, the trends observed from the stratified regressions did display differences in magnitude and direction of associations between sexes.

Discussion

Our HNA helped to characterize this small Nicaraguan community. In this community there is substantial overweight and obesity in women, but not in men. This difference between sexes is potentially explicable by differences in physical activity. However, it seems more likely that this difference in overweight and obesity is multi-factorial in origin, with the majority of these factors unaccounted for in our survey tool. Additionally, our HNA identified that there was considerable prevalence of hypertension in the community, however it was not as high as previous estimates for Nicaragua overall. This lower prevalence could be due to the rural nature of the community, as other country level studies have shown that there are higher levels of hypertension and other chronic diseases in urban rather than rural zones.[4]

Our methods were useful in identifying priorities for chronic disease programming in the small Nicaraguan community where AMOS works. Overall, the most valuable information which we obtained from this evaluation was the descriptive statistics regarding physical activity and prevalence of hypertension and overweight/obesity. These statistics also helped to characterize a community with low smoking and drinking, and notable consumption of fried processed foods and sugary drinks. The

majority of the population also has never been screened for diabetes. It was also made clear that adequate physical activity, work-related physical activity, drinking, and smoking are largely relegated to men. Also, men showed lower health seeking behavior than women as demonstrated by proportion of current community members with hypertension currently receiving treatment. Using this information, it would be sensible to target diabetes screening, physical activity in women, and consistent provision of anti-hypertensive medications.

The use of regression modeling to analyze our data proved to not be particularly useful, partially due to limitations of our analysis. There was some limited evidence of effect modification, combined with differences in behaviors shown in our descriptive statistics, might indicate that different interventions should be adopted for men and women in the community – particularly for alcohol use and physical activity.

We encountered several limitations in our HNA and analysis. A primary limitation was the small sample size which limited our ability to draw inference on potential predictors. We attempted to leverage that data that we did have and identify significant regression results through the use of multiple imputations; however we still failed to see any significant trends. We did not perform power calculations for these regressions ahead of time as we were not able to add any more subjects, nor did we see reason to not run our regressions due to lack of power. There is also likely some selection bias in the members if the community who were not surveyed which could lead us to over or under estimate certain trends and associations. As with all closed-ended surveys, the questions asked in the survey tool only included the things that the creators of the survey felt to be important at the time. Therefore, other potentially important concerns and factors could not be included in the analysis – and therefore not identifiable as areas for intervention. Additionally, there was no diabetes screening component, which was unfortunate as it would have helped to further illuminate the nature of chronic disease burden in the community.

Overall, our approach yielded helpful statistics which can serve as a useful starting point for planning and implementation of chronic disease initiatives. Given the investment of time and resources which went into the data collection, entering, and transportation, it is worth considering if the use of closed-ended surveys was the most efficient means of conducting a HNA for a community this small. Indeed, it would seem that a general idea of the factors at play which lead to overweight/obesity and hypertension in the community could be identified through qualitative methods. Qualitative methods would, theoretically at least, take less time and require fewer resources to arrive at ideally similar or perhaps broader answers. Yet, it should be kept in mind that this HNA was designed so that AMOS, Salud Juntos, and others may be able to use it in other small communities with the intent of comparing and pooling the resulting data. In closing, even though our advanced statistical analysis was not able to point to particular areas for intervention, we did a) provide a community screening of HTN and overweight/obesity, b) provide a general community baseline for a number of health behaviors and indicators. The latter of these two accomplishments will prove very valuable if we are able to implement community wide interventions over time. We feel that our descriptive results also help to point collaborators in the direction of particular interventions as outlined above. We hope that our results, as well as presentation and discussion of our methods, help others as they plan and implement HNAs which focus on chronic diseases in small communities throughout the world.

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Tables and Figures

Table 1: Demographic, Behavioral, and Disease Related Descriptive Statistics of Near-Universal Adult Sample in Small Rural Nicaraguan Town.

		MEN (n = 46)		WOMEN (n = 45)	
Variable	**Group**	**#**	**Pct.**	**#**	**Pct.**
Body Mass Index (kg/m^2)	Mean (SD)	22.79	3.64	25.59	5.19
	Underweight	4	9.1	2	4.44
	Healthy weight	30	68.18	16	35.56
	Overweight	7	15.91	18	40
	Obese	3	6.82	9	20
Age, years	20-29	11	23.91	20	20
	30-39	9	19.57	12	26.67
	40-49	9	19.57	7	15.56
	50-59	5	10.87	6	13.33
	60-69	5	10.87	7	15.56
	70-79	4	8.7	2	4.44
	80-89	1	2.17	2	4.44
	90-99	2	4.35	0	0
Smoker Type	Never	13	30.95	36	92.31
	Current non-daily	9	21.43	0	0
	Current daily	9	21.43	1	2.56
	Former	11	26.19	2	5.13
Drinker Type	Current non-drinker	32	69.57	45	100
	Current non-binge drinker	4	8.7	0	0
	Current binge drinker	10	21.74	0	0
Processed Snacks	Never	0	0	4	9.3
	Daily	20	45.45	18	41.86
	4-5x weekly	14	31.82	7	16.28
	2-4x weekly	5	11.36	10	23.26
	Once weekly	5	11.36	4	9.3
Daily Sugar Sweetened Beverages	Mean (SD)	2.34	(1.54)	1.58	(1.31)
Physical Activity	Recommended	41	91.11	13	29.55
	Insufficient	2	4.44	23	52.27
	Sedentary	2	4.44	8	18.18
Diagnosed with HTN in the Past	Yes	6	13.64	14	31.11
	No	38	86.36	31	68.89
Currently taking HTN Medications (of those diagnosed w/ HTN)	Yes	1	16.67	8	57.14
	No	5	83.33	6	42.86

Uncontrolled BP at Survey	Yes	7	15.22	5	11.11
	No	39	84.78	40	88.89
Hypertensive	Yes	7	15.91	11	24.44
	No	37	84.09	34	75.56
Diabetes Status	Never tested for DM	37	86.05	30	68.18
	Tested neg. for DM	5	11.63	11	25.00
	Diagnosed with DM	1	2.33	3	6.82

Table 2: Regression Results for Tested Predictors of Body Mass Index and High Risk Hypertension of Near-Universal Adult Sample in Small Rural Nicaraguan Town

Predictor Tested	β[a]	95% CI		p-value
Linear Regression[b] of Body Mass Index (n = 91)				
Fried Processed Food Consumption[c]	-0.34	-1.50	0.83	0.56
Physically Active[d]	-1.65	-5.29	2.00	0.36
Adequate Physical Activity[e]	0.14	-3.38	3.66	0.94
Daily Sugary Drinks	-0.17	-0.78	0.45	0.59
Current Drinker	-2.03	-4.85	0.80	0.15
Logistic Regression[f] of High Risk Hypertension (n = 91)				
Fried Processed Foods	-0.33	-0.85	0.18	0.21
Physically Active	-1.43	-3.80	0.94	0.24
Adequate Physical Activity	0.10	-1.32	1.52	0.89
Daily Sugary Drinks	0.05	-0.38	0.48	0.82
Current Drinker	-1.24	-3.88	1.40	0.36
Current Smoker	-1.44	-3.60	0.72	0.19

[a]Beta for linear regression represents change in BMI points (kg/m^2) for every increase of full integer value of listed predictor. Beta for logistic regression represents change in log odds for being a high risk hypertensive for every increase of full integer value of listed predictor.

[b]Linear regression used multiply imputed data (m=10), controlled for sex and age, and was clustered by household.

[c]Ordinal variable which categorizes fried processed snack consumption from daily to less than weekly.

[d]Binary variable of if individual is active or inactive according to CDC guidelines cited in methods.

[e]Binary variable of if individual is adequately or inadequately physically active according to CDC guidelines cited in methods.

[f]Logistic regression used multiply imputed data (m=10), controlled for sex and age, and was clustered by household.