Migration History, Health Behaviors, and Cardiovascular Disease Risk Factors in Overweight Mexican-American Women

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Purpose: This research examined whether the migration history of overweight Mexican-American women had an independent effect on cardiovascular risk factors, or whether it was mediated by health behavior changes.

Data and Methods: Cross-sectional data from 390 overweight, non-diabetic Mexican-American women (aged 18 to 65 years), all recruited from Starr County, Texas, were used for this analysis. Migration history was inferred from birthplaces of subjects and relatives, and length of residence in the United States. Health behaviors included tobacco and alcohol use, sleeping, exercise, and dietary practices. The cardiovascular disease risk factor variables (CDRFVs) studied were plasma glucose, abdominal obesity, blood pressures, and blood lipids. A migration history score (MHS) was developed from factor analysis, almost equally contributed to by the 9 migration history variables. Healthy habits were defined by 6 variables, and 3 factors (blood pressures, lipids/glucose, and body fat/glucose) were used for the CDRFVs.

Findings and Conclusion: MHS was correlated positively with socioeconomic status, and negatively with family stress. Older women had healthier drinking and sleeping habits. Women with a higher migration history score exhibited poorer exercise habits, and increased blood pressures. After adjusting for the effect of healthy exercise habits on blood pressures, the impact of migration history on blood pressures became non-significant ($P>.05$), leading to the conclusion that healthy exercise behaviors mediated the negative relationship of MHS with blood pressures. Age was independently positively correlated with all CDRFVs. Age also weakly moderated the negative relationship of MHS and healthy exercise habits. (*Ethn Dis.* 2003;13:94–108)

Key Words: Cardiovascular Disease Risk Factors, Health Behavior, Mediator-Moderator Relationships, Mexican-American Women, Migration History

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Introduction

Studies in Mexican-American populations have demonstrated that healthy behavioral practices (such as physical activity, moderate alcohol consumption, tobacco avoidance, weight control, and regular sleeping habits) are correlated with improved physical health and have a positive influence on survival in middle-aged, as well as elderly, men and women.[1,2] Consequently, unhealthy behaviors are major factors contributing to an increased risk of cardiovascular diseases in Mexican Americans.[3,4] In addition, a body of literature, largely separate from the one mentioned above, has reported that health behaviors change in response to adaptation to the host culture among immigrants.[5–8] Thus, a question can be raised as to whether: 1) the high prevalence of cardiovascular disease risk factors in Mexican Americans is directly associated with their migration history (ie, whether this ethnic association is a consequence of migration-related stress), independent of their health behaviors; or 2) the association of migration history and cardiovascular disease risk factors is mediated by health behaviors.

No study to date has examined the effects of health behavior on cardiovascular disease risk in conjunction with the migration history of Mexican Americans to address the above questions. Our research examined this 3-way link of cardiovascular disease risk factors, health behavior, and migration history in a cross-sectional sample of Mexican-American women from several communities of Starr County of South Texas. Specifically, the question addressed was whether or not migration history and health behavior interactively affect disease risk factors, and, if so, we wanted to ascertain the direction and strength of this effect. We also wanted to determine whether the women's age and socioeconomic status would moderate the effects of migration and health behaviors on cardiovascular health. In particular, the 3 study objectives were: 1) to examine whether health behaviors were dependent on age and migration history. Hypothesis: With a longer history of residence in the United States, there will be a change in health habits toward 'unhealthy'. As a corollary, age and/or family stress (socioeconomic status, unemployment, and disturbed family environment) may moderate the influence and direction of migration effects; 2) to assess the degree to which health behaviors were associated with cardiovascular disease risk factors in Mexican-American women. Hypothesis: Healthy behaviors are inversely related to cardiovascular disease risk factors (increases in body mass index, waist/hip circumference ratio, blood pressure, plasma glucose, cholesterol, and triglyceride levels). Age, family stress, and socioeconomic status may act as moderating factors in such associations as well; and 3) to examine whether or not the migration history was associated with chronic disease risk factors in Mexican-American women. Further, we wanted to investigate whether this association is a direct one, or whether differences in cardiovascular disease risk factors are mediated by the effects of health practices. Hypothesis: The effects of migration history on health outcomes are mediated by health behaviors, as indicated by a reduction in the contribution of migration history to health outcomes, after adjusting for health behaviors. Further, this effect is independent of potential interactions of these predictor variables with age, socioeconomic status, and family stress.

Therefore, the 3 study objectives and their relevant hypotheses were prompted by the rationale of establishing a 3-way link of migration history, health behaviors, and cardiovascular disease risk factors in overweight Mexican-American women. It was postulated that a statistical analysis of this 3-way link would determine whether migration history had an independent effect on cardiovascular risk factors, or whether it was mediated by health behavior changes in these women.

MATERIALS, CONSTRUCTS OF VARIABLES, AND ANALYTICAL METHODS

Study Population

Baseline cross-sectional data from a study entitled "Unidos en Salud: Weight Loss for Mexican Americans" were used to address the above objectives. "Unidos en Salud" was initiated in 1993, at which time 390 Mexican-American women were recruited from several communities (predominantly Rio Grande City, Roma-Los Saenz, and La Grulla) of Starr County in southern Texas along the US/Mexico border, approximately 550 kilometers southwest of Houston, Texas. In order to be included in this study, the subjects had to be of Mexican-American descent (determined by self-identification), aged 18–65 years, with a body mass index (BMI, kg/m^2) of 25–40 (ie, overweight); subjects could not be diabetic or pregnant. Other details of the sampling design of the weight loss study are described by Poston et al.[9] The sample was representative of the high risk group of overweight women in Starr County, Texas. A bilingual questionnaire consisting of 12 parts (each administered by trained bilingual interviewers to the subjects) was used in data collection at the Rio Grande City Diabetes Alert office, established by the University of Texas Human Genetics Center as a field office in Starr County, Texas. During interviews, the subjects were instructed to respond in either Spanish or English, according to their preference. The cross-sectional data generated the following 4 different categories of variables, which are used in the present analysis.

> *"Our research examined this 3-way link of cardiovascular disease risk factors, health behavior, and migration history in a cross-sectional sample of Mexican-American women from several communities of Starr County of South Texas."*

Demographic Variables

This category includes 3 separate types of variables

1) Age of Subjects: Age, verified from birth records and family interviews, was computed in nearest years. The range was from 18 to 65 years, with a mean age of 39.4 years (SD=10.7), and with approximately 71.5% (279 of the 390) of subjects being age 45 years or less, while the remaining 111 (28.5%) were aged 45 years and older.

2) Socioeconomic Status (SES): In the context of a study on cardiovascular disease risk factors in a population of similar socio-cultural background, Hazuda and colleagues demonstrated the reliability of the Duncan Socioeconomic Index (SEI), a global measure based on occupational prestige, in determining SES.[10–12] Household income data were not available from the "Unidos en Salud" project; therefore, SES for the present analysis was measured by SEI based on the occupation of the subject and her spouse (where available).

3) Family Stress: Stability of family conditions (ie, marital status), levels of income and employment are among variables that have been used previously in assessing the health effects of stressor conditions.[13] Marital and employment status were recorded for all women. Family stress was measured on the basis of marital status (scored as 0=married; 1=single; 2=widowed; and 3=divorced), and the employment status (scored as 0=working; 1=retired; 2=unemployed; and 3=disabled) of the subject and her existing spouse. The women sampled were predominantly married (73.8%), and/or were employed (68.9%) or had a working husband (75.9%). For married women, the 2 employment status variables (subjects' and their husbands') were used with the marital status score to assign a family stress score (average of the 3). With subjects for whom one or more of these items was not recorded, the average of the remaining became the family stress score. Family stress was treated as a continuous variable.

Migration History

Information regarding the participants' migration history was also collected by trained bilingual research assistants using questionnaires validated

Table 1. Migration history variables, scores assigned to each category and the frequency distribution of subjects

Item	Category	Score	Frequency (%)
Years of residence	<5 years	0	21 (5.4)
	5–9 years	1	30 (7.7)
	≥10 years	2	339 (86.9)
Immigration status	1st generation	0	109 (27.9)
	2nd generation	1	11 (2.8)
	≥3rd generation	2	270 (69.2)
Birthplace of			
Subjects	Mexico/other	0	109 (27.9)
	USA	1	281 (72.1)
Father	Mexico/other	0	127 (33.6)
	USA	1	251 (66.4)
Mother	Mexico/other	0	145 (37.8)
	USA	1	239 (62.2)
Father's father	Mexico/other	0	177 (53.8)
	USA	1	152 (46.2)
Father's mother	Mexico/other	0	180 (54.2)
	USA	1	152 (45.8)
Mother's father	Mexico/other	0	192 (55.8)
	USA	1	152 (44.2)
Mother's mother	Mexico/other	0	192 (54.9)
	USA	1	158 (45.1)

for use among Mexican-American populations. Migration history variables included birthplace of subject, her parents, and her grandparents (Mexico- vs US-born); and length of residence in the United States. Language preference was not used in the migration history score because this variable presented several methodological problems. For example, opportunities for community exposure to alternative languages for the women's daily activities were not specifically noted; further, the responses to the language preference questions were also internally inconsistent. Table 1 lists the 9 migration history variables with their respective frequency distributions.

Missing items were present in some migration history variables (mostly for birthplaces of grandparents). However, they represented a random loss of information, as the frequencies shown in Table 1 did not differ from those in the sub-sample (N=303) with complete records. As seen from these distributions, the majority of the women (86.9%) had resided in Starr County, Texas, for 10 or more years, and more than 69% of them were at least third-generation immigrants. Two-thirds or more of the subjects and their parents were born in the United States, with only slightly more than 50% of the grandparents having been born outside the United States (mostly in Mexico).

A composite score of migration history (MHS) was obtained by standardizing each variable (mean=0, SD=1.0), then averaging scores from all available items, thereby maximizing the number of subjects for whom the MHS variable could be defined, without introducing any systematic bias. This method of defining MHS was validated by a factor analysis of the 9 items of migration history variables (in which the principal factors were extracted with varimax rotation—employing the software of SPSS 9.1). The first principal factor had an eigenvalue of 5.505, with 61% of the variance explained. The next component accounted for only 11% of the variance. The scree plot suggested that one factor suffices the summarization of the 9-item migration history variables. The coefficients of the component matrix for the first principal factor were nearly equal (ranging from 0.755 for paternal grandfather's birthplace to 0.932 for immigration status), except for the years of residence (with a coefficient of 0.257). The correlation of the first factor with MHS was 0.995, lending support to the validity of using MHS as a migration history score. Tertiles of the distribution of MHS defined the 3 categories of migration history described operationally as 'recent,' 'intermediate,' and 'long-term' migrants. While in principle, this method of defining MHS was similar to those employed by others,[14,15] we avoided a simple sum of all 9 items, because the number of categories within each item were not equal (Table 1).

Health Habits

Three different and specifically designed and validated (bilingual) questionnaires were used to collect data for this group of variables: one for smoking and drinking history, a second for food frequency, and a third for physical activity. These yielded health behavior data consisting of tobacco use, alcohol consumption, hours of sleep, physical exercise, and dietary habits (Table 2). For current smokers and drinkers, the number of cigarettes smoked per day (in units of pack/day) and the number of drinks (beer, wine, and liquor) consumed per week were also recorded. However, since quantitative information on tobacco and alcohol use was incomplete for most smokers and regular drinkers, we used simple categories to designate health habits: non-smokers (ie, score of 1, representing a healthy habit); past/present smokers (ie, score of 0, representing an unhealthy habit); moderate or non-drinkers (scored as 1); and heavy-drinkers (scored as 0, unhealthy). This method of scoring the consumption of tobacco and alcohol as healthy or unhealthy was adopted for 2 reasons. First, the method was identical to those used in other migration-related health studies.[1,14] Second, separate validation studies of self-reported smoking habits of Mexican Americans indicated a tendency among moderate to heavy

Table 2. Health behavior variables, scores assigned to their categories and the frequency distribution of subjects

Item	Category	Score	Frequency (%)
Tobacco	Never smoked	1	305 (78.2)
	Past/current smoker	0	85 (21.8)
Alcohol use*	Moderate or non-drinker	1	293 (75.1)
	Heavy drinker	0	97 (24.9)
Sleeping habits†	7–8 hours/night	1	222 (57.5)
	<7 or >8 hours/night	0	164 (42.5)
Exercise habits	Healthy (≥37 kcal/kg/day)	1	109 (28.2)
	Sedentary (<37 kcal/kg/day)	0	278 (71.8)
Dietary habits:			
Total fat	<30% of TFEI‡	1	115 (35.1)
	≥30% of TFEI	0	213 (64.9)
Saturated fat	<10% of TFEI	1	109 (33.2)
	≥10% of TFEI	0	219 (66.8)

Note: Data on sleeping and exercise habits are from the 7-day PAR questionnaire, and total/saturated fat data are from a 3-day recall specialized questionnaire. Tobacco and alcohol use data are from a separate questionnaire.

* Moderate drinkers are defined as those who drink 1–2 drinks per setting once or more times per week. Heavy drinkers are those who drink 3 or more drinks per setting once or more times per week.

† Sleeping habits defined as healthy (ie, score = 1) for women who sleep 7–8 hours/night for 4 or more nights during the week, and unhealthy (ie, score = 0) for those who sleep <7 or >8 hours/night 4 or more nights during the week.

‡ TFEI is the total food energy intake, measured in units of calories/day.

smokers to under-report the number of cigarettes smoked; however, self-reporting bias considerably reduced the misclassification of past/present smokers vs non-smokers.[16,17]

Sleeping and exercise habits were recorded with an established and validated 7-day Physical Activity Recall (PAR).[18,19] The PAR estimates hours of sleep and time spent in 4 levels of daily activity (light, moderate, vigorous, and very vigorous). This procedure is validated as an estimate of energy expenditure with accelerometers (r=0.79).[20] The information from the 7-day PAR was translated into kcal/kg/day energy expenditure, using an algorithm demonstrated to provide valid estimates of physical activity in general population studies, and in Latino populations, in particular.[21] Sleep was measured as the number of hours spent sleeping per night, and the number of times the subjects slept for any specified number of hours/night over a 7-day recall period, information which was extracted from the physical activity recall questionnaire. Using this procedure to measure sleeping habits generated a continuous variable. However, epidemiological studies have indicated that either too much or too little sleep is generally unhealthy.[1] Cantero and colleagues defined 7–8 hours of sleep per night on a frequent basis as a healthy (regular) habit, with fewer or more hours of sleep per night on a continual basis categorized as unhealthy.[14] Therefore, for the present analyses, the sleeping habit variable was dichotomized as 'healthy' (ie, score of 1, for subjects who sleep 7–8 hours/night for 4 or more nights during the week), and 'unhealthy' (ie, score of 0, for subjects who sleep <7 or >8 hours/night at least 4 nights during the week).

Nutritional data were collected through a 3-day dietary recall questionnaire, transformed into total food energy intake (TFEI, measured in units of calories/day), and intake of fat and saturated fat. This questionnaire was a modified version of the one developed as part of an epidemiologic study of gallbladder disease in the same population of Starr County,[22] which was, in turn, adapted from a quantified food frequency questionnaire (FFQ), which can be easily administered, requires no post interview coding, and can be completed quickly and inexpensively.[23] A separate validation study in the same population of Mexican Americans reported the correlations between nutrients computed from the 3-day food records and the original FFQ as 0.77, 0.76, and 0.74 for energy, total fat, and saturated fat, respectively.[24] In the same study, administration of this population-specific FFQ in Mexican-American subjects for 3 consecutive months resulted in high repeatability. For example, correlations ranged from 0.90 for energy, to 0.85 for total fat, between estimates based on repeat FFQ measurements a month apart; and 0.84 for energy to 0.70 for total fat for measurements taken 2 months apart. Total food energy intake (TFEI) was defined as all nutrients (ie, protein, fat, carbohydrate, and alcohol) derived from consumption of food and beverages, measured in kilocalories (kcal). The percentages of TFEI from total dietary fat and saturated fat were selected as indicators of dietary health habits in relation to chronic disease risk factors. This was prompted by the observation that excessive dietary fat intake is associated with increased risk of obesity, coronary heart disease, and certain cancers.[25–29]

With regard to sleep, and tobacco and alcohol use, the women had predominantly healthy habits (Table 2). Over 78% of the women had never smoked; approximately 75% were non- or moderate drinkers; and 57.5% had regular sleeping habits (7–8 hours per night for at least 4 nights/week). In contrast, exercise habits were predominantly unhealthy, with 71.8% being sedentary (with <37 kcal/kg/day energy expenditure); 64.9% had a total fat intake of more than 30% of the total food energy intake (TFEI); and 66.8% reported unhealthy levels of saturated fat intake (ie, >10% of TFEI). As in the case of the migration history items, complete data on all 6 health habits were available for 323 women (largely contributed by 68 records with missing data for fat intake measurements, attributed to the incomplete answers in the FFQ administered). Frequency distribution computations, excluding records on missing observations yielded virtually identical univariate distributions for 6 health habit items, suggesting there was not a nonrespondent bias in the data. However, we did not follow the current practice of defining a composite health behavior score as the summed score of the 6 item health behaviors for two reasons.[1,14] First, the different health items did not contribute equally to a single factor, evaluated through a factor analysis of the 6 health habit variables. In fact, a single factor did not adequately explain the total variance of the 6 health habit variables. Second, the first 4 principal factors (together accounting for 85.3% of the variance) grouped the 6 health habit variables in 4 separate and uncorrelated groups (fat intake, healthy exercise habit and alcohol use, tobacco and alcohol use, and sleeping habits), with items within each group partially related. Thus, the 6 binary health behavior scores were individually used as 6 dimensions of health behavior variables.

Table 3. Chronic disease risk factor (CDRF) variables, scores assigned to their categories, and frequency distribution of subjects

Item	Category	Score	Frequency
Body mass index (BMI, kg/m²)	25 < 30 (overweight)	0	109 (28.0)
	30 < 35 (obesity class-I)	1	150 (38.6)
	35 < 40 (obesity class-II)	2	76 (19.5)
	≥40 (extreme obesity)	3	54 (13.9)
Waist-hip ratio (WHR)	1st quartile	0	97 (25.0)
	2nd quartile	1	97 (25.0)
	3rd quartile	2	98 (25.3)
	4th quartile	3	96 (24.7)
Triglyceride (mg/dL)	<200 (desirable)	0	345 (88.7)
	200–399 (borderline high)	1	37 (9.5)
	400–999 (high)	2	7 (1.8)
	≥1000 (very high)	3	0 (0.0)
Total cholesterol (mg/dL)	<200 (desirable)	0	211 (54.2)
	200–239 (borderline high)	1	118 (30.3)
	≥240 (high)	2	60 (15.4)
Plasma glucose	<110 (normoglycemia)	0	334 (85.9)
	110–125 (impaired glucose)	1	32 (8.2)
	≥126 (diabetes mellitus)	2	23 (5.9)
Systolic blood pressure	<120 (optimal)	0	251 (64.9)
	120–129 (normal)	1	80 (20.7)
	130–139 (high normal)	2	26 (6.7)
	≥140 (hypertension)	3	30 (7.8)
Diastolic blood pressure	<80 (optimal)	0	313 (80.9)
	80–84 (normal)	1	50 (12.9)
	85–89 (high normal)	2	15 (3.9)
	≥90 (hypertension)	3	9 (2.3)

Note: The cut-off values are selected based on criteria set by NHLBI expert panels, reports of which are summarized in the American Heart Association web: www.americanheart.org/Hea_and_Stroke_A_Z_Guide.

Cardiovascular Disease Risk Factors

The cardiovascular disease risk factor variables (CDRFVs) are shown in Table 3, along with the frequency distributions of the subjects for each category. Body measurements included height, measured with a stadiometer, and weight, in kilograms, measured with a balance beam scale; both measurements were taken with participants barefoot and wearing light clothing. Body mass index (wt/ht² in kg/m²) was used as a general measure of obesity, and waist-hip ratio (WHR), as a measure of abdominal fat distribution, both of which characteristics are known to be associated with cardiovascular disease risk.[30–36] Trained technicians measured the waist at the umbilicus, or at the largest circumference, with a non-stretchable tape, and the hip at the level of the widest extension of the buttocks. Lipids (total cholesterol and triglycerides) and plasma glucose concentration were determined from a fasting (at least 10 hours) blood sample obtained by venipuncture. At the Starr County, Texas, Diabetes Alert office in Rio Grande City, lipid (cholesterol and triglycerides) and glucose measurements were taken using the Reflotron® machine (Boehringer Mannheim Diagnostics) following the manufacturer's protocol. Validation studies indicate that the field measurements of cholesterol by Reflotron correlates >0.90 with standard laboratory-based measurements,[37] and at an even higher rate (r>0.98) for glucose and triglycerides.[38] For measuring fasting glucose and lipid levels, blood was sent to the Human Genetics Laboratory of the University of Texas Health Science Center at Houston, where these variables were measured by protocols after those used in other epidemiologic studies.[22,39] Blood pressure was measured by using a random zero sphygmomanometer. As the guidelines of the American Heart Association specify, averages of the last 2 of the 3 blood pressure measurements (for systolic as well as diastolic) were used.[40]

Frequency distributions of the subjects for the 7 CDRFVs (with the exception of BMI and WHR) showed that few subjects had high or borderline high risk factors for cardiovascular disease, with the exception of BMI and WHR. Moderate pairwise correlations of the 7 CDRFVs (16/21) were statistically significant, with the highest (0.46) between blood pressures, indicating that a simple summed score may be inadequate to characterize risk. This was confirmed by factor analysis. A scree plot, as well as the examination of the eigenvalues suggested that the data could be summarized adequately by 3 factors.

The first factor reflected blood pressure, the second, lipids, and the third, BMI, with WHR and glucose being equally split between the second (lipid) and third (body fat) factors. The positive loadings for each variable in each factor score indicated that the larger the factor score, the greater the risk for cardiovascular disease. A composite risk score, CRS, was defined by summing the 3 factor scores, CRS = F1 + F2 + F3.

Previous researchers have used summed scores of risk variable categories, as shown in Table 3, as indices of cardiovascular disease risk.[1,4] A comparison of this summed disease risk score with the one defined by the above factor analysis (CRS), indicated that the measures are virtually identical (r=0.997, P<10^{-4}), and that either could be used. However, for the subsequent analyses, F1, F2, and F3 separately, as well as CRS, were retained as indices of cardiovascular disease risk, since: 1) CRS explained 63.6% of the total variance of the seven CDRFVs; and 2) the uncorrelated F1, F2, and F3 grouped the 7 risk variables into 3 distinct and interpretable sets of variables.

Analytic Methods

With the definition of variables as described above, the health behavior variables were binary, and all others (age, SES, family stress, MHS, and cardiovascular risk factor scores) were continuous. Therefore, for assessing correlations, both parametric (Pearson's product moment) and nonparametric (Spearman's ρ) measures were employed. Logistic regression was used with the binary dependent variables (ie, healthy habits), but when the dependent variable was continuous, multiple linear regression models were used for hypothesis testing.

Hypothesis 1: (Longer history of migration adversely changes health behaviors; age, socioeconomic status and family stress may act as potential confounders, moderators, or mediators in this relationship). To test this hypothesis, the 6 binary health behavior variables (total and saturated fat intake, alcohol and tobacco use, exercise, and sleeping habits) were the dependent variables with MHS (continuous) as the principal independent predictor. Age, socioeconomic status, family stress, and the interactions of these (among themselves as well as with MHS) were additional independent variables, as they could potentially confound, mediate, or moderate the relation of migration history (MHS) and health behaviors. The logistic regression routine of the SPSS (9.1 version) software was used for parameter estimation and for testing the adequacy of the fitted models.

Hypothesis 2: (Healthy behaviors are inversely related to chronic disease risk factors; age, SES, and family stress may be potential confounders/moderators/mediators in this relationship). The influence of health habits on chronic disease risk factors was analyzed by multiple regression analysis of the 3 cardiovascular disease risk factor scores (F1, F2, and F3), and their sum on the 6 health behavior variables that were significantly related to one or more of the 4 dependent variables. Terms involving age, SES, family stress, and the intereactions of these with all 6 health behavior variables were also entered in the regression equations, in order to determine whether these variables played any confounding, moderating, and/or mediating roles. WHR was added as an extra predictor in the final model of dependence of F1 and F2 on health behaviors so that we could ascertain whether the relationships of health behaviors to blood pressures (F1) and lipid/glucose (F2) were affected by inclusion of only overweight women in this study.

Hypothesis 3: (Migration effect on chronic disease risk factors is mediated through health behavior changes). The combined influence of MHS and health habits on cardiovascular disease risk factors was studied by a set of 2-stage multiple regression analyses. Again, the 3 cardiovascular disease risk factor scores (F1, F2, and F3) and their sum were the dependent variables (used in 4 separate sets of analyses). In the first stage, MHS was the predictor, along with age, SES, family stress, and all 2-factor interactions. Eliminating terms with consistently non-significant contributions, the simplest model was taken as the final model (Model I), specifying the influence of MHS on cardiovascular disease risk factors. In the second stage, the 6 health behavior variables (and their interactions with terms of the predictors of Model I) were added as additional predictors. Terms were eliminated that were not significantly related to the outcome measures, producing a final model (Model II). This was compared with Model I to determine the change of explained variance (R^2), in order to evaluate whether healthy habits had a mediating role on the influence of MHS on CDRFVs.

RESULTS

Migration History and Its Dependence on Age, SES and Family Stress

The first block of 4 rows and columns of Table 4 displays the correlation coefficients (with Spearman's nonparametric correlation, ρ, above the diagonal, and Pearson's product moment correlation, r, below the diagonal) of the continuous scores of age, family stress, SES, and MHS. Age was not significantly related to MHS or family stress by either measures of correlation. Only the rank correlation (Spearman's ρ) between age and SES was marginally significant (ρ=0.085, P=.046), but the product-moment correlation was not (r=0.069, P=.088). Thus, MHS and family stress were not age-dependent in these Mexican-American women, and the positive correlation of age and SES was weak, at best. In contrast, MHS was positively correlated with SES (r=0.288, ρ=0.264, P<.001 for both),

Table 4. Product-moment (lower diagonal) and nonparametric (Spearman's Rho, upper diagonal) correlations among all 14 variables

	Age	Stress	SES	MHS	Smoking	Drinking	Exercise	Sleeping	Tot. Fat	Sat. Fat	CDRF1	CDRF2	CDRF3	CRS
Age		0.037	0.085*	0.018	−0.066	0.103*	0.014	0.115*	0.018	0.032	0.295†	0.261†	0.133†	0.394†
Stress	0.040		−0.300†	−0.175†	0.006	0.054	0.006	−0.061	−0.036	−0.066	0.007	0.080	−0.005	0.005
SES	0.069	−0.353†		0.264†	−0.026	−0.047	−0.064	0.058	0.019	−0.020	0.030	−0.046	−0.024	0.068
MHS	0.048	−0.171†	0.288†		0.003	−0.006	−0.111*	−0.057	−0.056	−0.057	0.072	−0.022	0.010	0.045
Smoking	−0.065	−0.002	−0.014	0.006		0.154†	−0.038	0.030	−0.001	0.011	−0.035	−0.092*	−0.007	−0.083
Drinking	0.107*	0.027	−0.037	−0.037	0.154†		0.124†	−0.027	0.075	0.084	0.004	−0.003	−0.045	−0.022
Exercise	0.006	−0.020	−0.073	−0.152†	−0.038	0.124†		−0.043	−0.072	−0.091*	−0.131†	−0.057	−0.048	−0.144†
Sleeping	0.113*	−0.050	0.074	−0.039	0.030	−0.027	−0.043		0.052	0.034	0.039	0.105*	−0.029	0.024
Tot. Fat	0.025	−0.029	0.027	−0.058	−0.001	0.075	−0.072	0.052		0.892†	−0.019	0.023	−0.058	−0.013
Sat. Fat	0.042	−0.048	−0.003	−0.062	0.011	0.084	−0.091*	0.034	0.892†		−0.029	−0.018	0.013	0.011
CDRF1	0.312†	−0.037	0.087*	0.128†	−0.040	0.001	−0.146†	−0.001	−0.006	0.006		0.088*	−0.139†	0.356†
CDRF2	0.243†	0.018	−0.032	−0.017	−0.093*	−0.004	−0.034	0.079	0.005	−0.030	0.000		−0.109*	0.436†
CDRF3	0.122†	0.008	0.026	0.019	−0.001	−0.044	−0.048	−0.034	−0.056	0.012	0.000	0.000		0.627†
CRS	0.391†	−0.006	0.047	0.075	−0.077	−0.027	−0.132†	0.025	−0.032	−0.007	0.577†	0.577†	0.577†	

Note: The 4 demographic variables (age, SES, family stress, and MHS) are continuous, the 6 health habit variables (smoking, drinking, exercise, sleeping, total fat and saturated fat intake habits) are binary discrete, and the 4 CDRF factor variables (CDRF1=blood pressures; CDRF2=lipids/glucose, CDRF3=BMI/WHR/glucose, and CRS=CDRF1 + CDRF2 + CDRF3) are continuous.

* Are significant at 5% (one-tail) level.

† Are significant at 1% (one-tail) level.

and negatively correlated with family stress ($r=-0.171$, $\rho=-0.175$; $P<.01$ for both). Women with higher MHS scored higher on SES and had less family stress. Consistent with this finding, a significant negative correlation was observed between SES and family stress ($r=-0.353$, $\rho=-0.300$; $P<.001$ for both).

Effects of Migration History on Health Behavior

Correlations of age, family stress, SES, and MHS (continuous scores of all) with the 6 health habit variables (all treated as binary) are shown in the second block of Table 4 (again, the above diagonal entries are Spearman's ρ, and below the diagonal are Pearson's product moment correlations, r). Healthy exercise habit (ie, energy expenditure $\geq$37 kcal/kg/day) was the only variable significantly correlated (negatively) with MHS ($r=-0.152$, $P<.01$; $\rho=-0.111$, $P<.05$). Women with higher MHS exercised less, compared to groups who had lower scores of MHS. While the other health habit variables were not significantly correlated with MHS, sleeping and drinking habits were positively correlated with age ($P<.05$ for ρ as well as r). Compared to younger women, older women had healthier sleeping and drinking habits.

Logistic regression analyses (Table 5) of healthy behaviors on the predictors (age, SES, family stress, and MHS) supported the results of the correlation analysis. Healthy exercise behaviors diminished for women with higher values of MHS, with $\beta_{MHS}=-0.432 \pm 0.156$ ($P=.006$). This yielded an odds ratio for MHS of 0.65 (95% CI 0.48–0.88), implying that for every unit increase in the MHS score, the odds of healthy exercise decreased by a factor of 0.65. Healthy drinking and sleeping behaviors were more prevalent among older women ($\beta_{age}=0.025 \pm 0.011$, $P=.031$, and $\beta_{age}=0.022 \pm 0.010$, $P=.027$, respectively, for drinking and sleeping). Neither age, SES, family stress, nor MHS

Table 5. Logistic regression coefficients (logit ± s.e.) of health habits on age, SES, family stress and composite migration history score (MHS)

Independent Variables (all continuous)	Health Habit Variables					
	Smoking	Drinking	Exercise	Sleeping	Total Fat	Saturated Fat
Age	−0.015 ± .012	0.025 ± .011*	0.004 ± .011	0.022 ± .010*	0.006 ± .011	0.010 ± .011
Family Stress	−0.007 ± .207	0.024 ± .202	−0.239 ± .202	−0.134 ± .177	−0.107 ± .197	−0.230 ± .203
SES	−0.002 ± .007	−0.004 ± .006	−0.006 ± .006	0.007 ± .006	0.003 ± .006	−0.001 ± .006
MHS	0.042 ± .171	−0.096 ± .165	−0.432 ± .156†	−0.197 ± .146	−0.210 ± .161	−0.213 ± .163

Note: With age, SES, family stress, and MHS treated as continuous variables in the above regression models, no interaction term (including the age × MHS term) was significant (at 5% level).
* $P<.05$.
† $P<.01$.

influenced other health habit variables significantly, nor were there any significant interactions.

In view of the negative influence of MHS on healthy exercise behaviors, we also examined how the proportion of women with healthy exercise behaviors varied among the 3 categories of migration history (Figure 1). Women categorized by two age classes (≤45, and >45 years of age) and 3 migration history classes (recent, intermediate, and long-term), showed different trends of healthy exercise behaviors by migration history in younger and older women. The proportion of younger women with healthy exercise behavior was the lowest among the intermediate class of migration history (20.5%), with both recent and long-term migrants exhibiting significantly greater percentages of healthy exercise behavior (32.6% and 30.3%, respectively). In contrast, among older women, the recent class of migration history had the highest proportion of healthy exercise behavior (51.2%), which decreased to 17.5% among the intermediate and long-term migrant classes, according to the computed MHS scale.

Correlations of CDRF Variables and Their Predictors (Table 4, third block of rows and columns)

The first CDRF score (F1, blood pressures) was significantly related to age (r=0.312, $P<.001$), SES (r=0.087, $P<.05$), healthy exercise behavior (r=−0.146, $P<.01$), and migration history (MHS, r=0.128, $P<.01$). Therefore, blood pressures increased with age and with improved SES, diminished with healthy exercise behavior, and increased with MHS. The second CDRF score (F2, lipids/glucose) was also related to age (r=0.243, $P<.001$), and to healthy smoking habits (r=−0.093, $P<.05$). In other words, lipid and glucose levels increased with age and were lower among non-smokers. The third CDRF score (F3, body fat/glucose) was related only to age (r=0.122, $P<.01$). The sum of the 3 risk factors, CRS, was positively correlated with age (r=0.391, $P<.001$), and negatively correlated with healthy exercise behavior (r=−0.132, $P<.01$).

Regression of CDRF Factor Scores on Health Habits, Age, SES, and Family Stress

To examine the effect of health behavior variables on CDRFVs, regression models were constructed to test for main effects and 2- and 3-factor interaction terms of all independent variables (age, SES, family stress, and 6 health behaviors; excluding interaction terms involving more than one health behavior). The regression models were simplified by dropping the insignificant interaction terms, and by eliminating main effects that were insignificant.

The simplest regression models for the 3 factor scores of CDRFVs, and for the composite risk score (CRS=F1 + F2 + F3), are shown in Table 6. F1 (blood pressure) was significantly related to age and healthy exercise behavior. Blood pressures were higher in older women (β_{age}=0.029 ± 0.005, $P<.001$), and lower in those with healthier exercise behavior ($\beta_{exercise}$=−0.324 ± 0.107, $P<.01$). F2 (lipids/glucose) and F3 (body fat/glucose), in contrast, were only affected by age. CRS, the sum of all 3 risk factors, followed the pattern of F1, increasing with age and poorer exercise behavior. All effects were independent of SES and family stress, and no interaction term was significant in any of the regression models.

Since the sampled women were all overweight, the relationships of the CDRF scores with age and exercise habits were also examined by adding WHR as an extra predictor in the first two regression models (lower half, Table 6). The addition of WHR in the regression models slightly, but significantly, improved the proportion of explained variance (R^2) in both regression models. However, there was no change in the contributions of the other predictors to either the blood pressure (F1) or lipid/glucose (F2) factor scores.

Regression of CDRF Scores on Health Habits, MHS, and Other Predictors

The effect of migration history on cardiovascular risk, and the combined effects of health behaviors and migra-

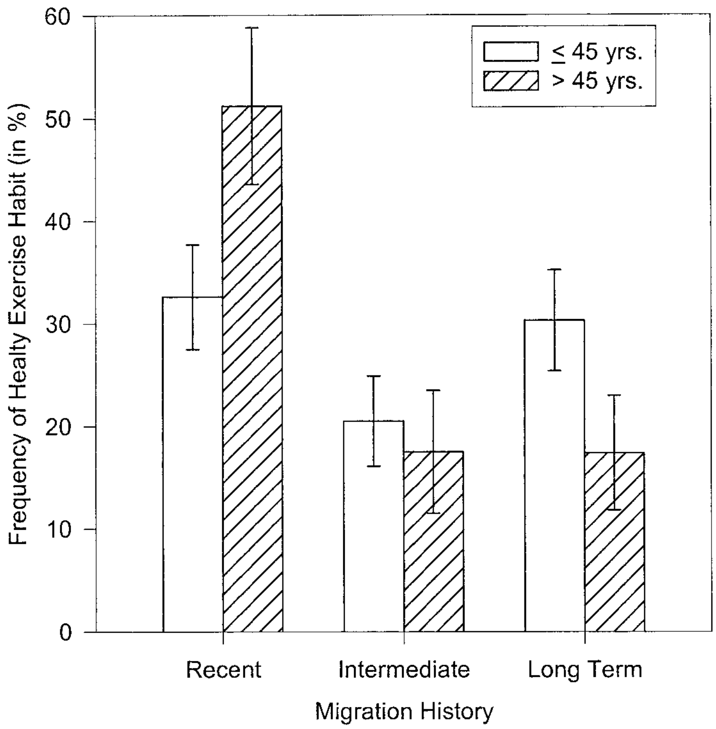

Fig 1. Frequency (in percent) of women with healthy exercise habits (ie, with ≥37 kcal/kg/day energy expenditure) by 3 categories of migration history and 2 age groups. The lines above each bar represent ± s.e. of the estimated proportions in each group.

tion history, are shown in Table 7. Being guided by the results of the first two objectives, it was only necessary to examine how F1 (blood pressures) was influenced by MHS, and how this association was affected by healthy exercise behaviors. Further, this analysis also examined whether or not the joint influence of MHS and healthy exercise behaviors on blood pressure remained valid, after adjusting for overweight. Two stepwise models of linear regression of F1 consisted of using age and MHS as the predictors (Model I), with the subsequent addition of healthy exercise behavior as an extra predictor (Model II). To adjust for the effects of only including overweight women in this study, WHR was subsequently added as an additional predictor in both models.

The regression model II better described the joint effects of (age), MHS, and healthy exercise behavior on blood pressures, as seen from the significant improvement in the proportion of explained variance (R^2). More importantly, the regression of MHS on F1 (blood pressures), significant in Model I, became insignificant when healthy exercise behavior was added as an additional predictor (Model II). The same trend was seen when the effect of WHR was adjusted for in the regression models I and II (lower half of Table 7).

Age as An Independent Predictor of Chronic Disease Risk

To examine whether the non-significant age × exercise habit interaction effect on blood pressures was influenced by treating age as continuous, and healthy exercise behavior as binary, the relationship of blood pressures with healthy exercise behavior was re-examined by categorizing age in two classes:

Table 6. The effect of healthy habits§ on chronic disease risk factors: linear multiple regression

	Factor Scores of Chronic Disease Risk Variables			
Significant Predictors	F1 (SBP/DBP)	F2 (Lipids/Glucose)	F3 (BMI/WHR/Glucose)	CRS (F1 + F2 + F3)
Age	0.029 ± .005‡	0.023 ± .005‡	0.011 ± .005*	0.063 ± .008‡
Exercise	−0.324 ± .107	—	—	−0.503 ± .180†
R^2	0.118	0.059	0.015	0.168
With adjustment for WHR:				
Age	0.026 ± .005‡	0.017 ± .005‡		
Exercise	−0.297 ± .107†	—		
WHR	0.111 ± .045*	0.190 ± .045‡		
R^2	0.132‖	0.101‖		

* $P<.05$.
† $P<.01$.
‡ $P<.001$.
§ Of the 6 healthy habit variables, only exercise habits was related to CDRFs.
‖ R^2 change with inclusion of WHR as an additional predictor is significant ($P<.05$). SBP=systolic blood pressure; DBP=diastolic blood pressure; BMI=body mass index (weight/height^2, in kg/m^2); WHR=waist-hip ratio; lipids include triglyceride and total cholesterol; CRS=composite chronic disease risk factor score=F1 + F2 + F3.

Table 7. The combined effects of healthy exercise habits and migration history on blood pressure risk factor (F1): linear multiple regression

Predictors	Model I§	Model II‖	Change of R^2
Age	0.028 ± .005‡	0.029 ± .004‡	
MHS	0.146 ± .065*	0.120 ± .065	
Exercise habit	—	−0.294 ± .108†	
R^2	0.109	0.126	0.017†
With adjustment of WHR:			
Age	0.025 ± 0.05‡	0.025 ± .005‡	
MHS	0.141 ± .064*	0.118 ± .064	
WHR	0.121 ± .045†	0.110 ± .045*	
Exercise habit	—	−0.268 ± .108*	
R^2	0.125	0.139	0.014*

Note: Other variables (eg, socioeconomic status and family stress) considered as additional predictors are not significant (at 5% level), and so are the interaction terms. Hence, they are excluded in the models shown above.
* $P<.05$.
† $P<.01$.
‡ $P<.005$.
§ CVDR Factor 1 (SBP/DBP) on age and MHS (with/without WHR).
‖ CVDR Factor 1 (SBP/DBP) on age, MHS, and exercise habit (with/without WHR). MHS=composite migration history score; WHR=waist-hip ratio.

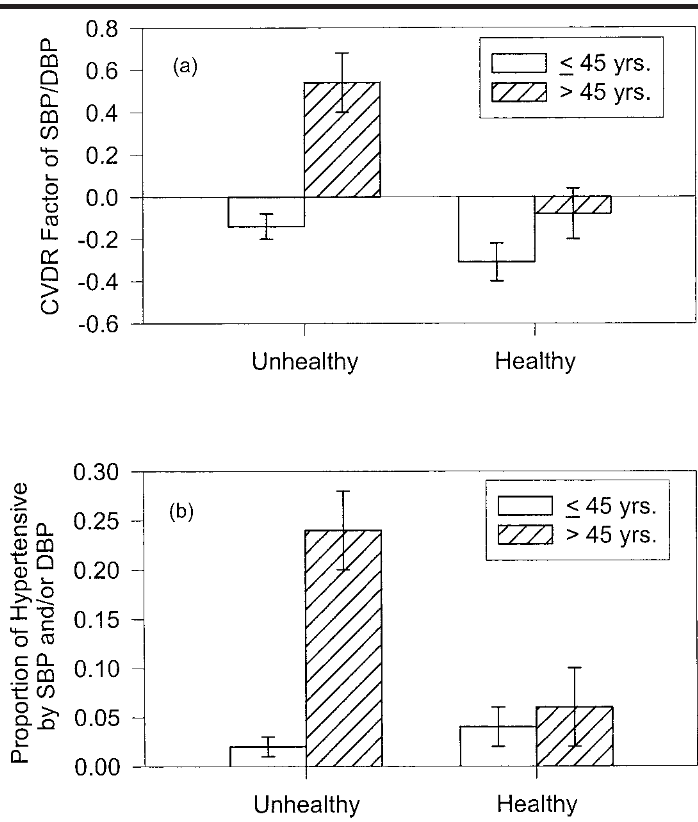

Fig 2. Mean (± s.e.) blood pressure factor score of women (panel a) and proportion (± s.e.) of hypertensive women (ie, with SBP ≥90, panel b), classified by their healthy exercise habits (unhealthy: <37 kcal/kg/day energy expenditure; healthy: ≥37 kacl/kg/day energy expenditure) and age (≤45 years, and >45 years).

≤45 years, and >45 years. Mean values of F1 and the proportion of hypertensive women (ie, SBP≥140 and/or DBP≥90), along with their respective standard errors, are shown in Figure 2, separated by healthy and unhealthy exercise behaviors. Consistent with the regression analysis results, ANOVA analysis of this data showed that older women scored significantly higher ($P<.001$) on the scale of F1 (blood pressures, panel a). By the criterion chosen, hypertension was also more common among older women (panel b). In addition, the relationships of healthy exercise behaviors with the F1 score (blood pressures), and with the prevalence of hypertension, were consistent with each other, with both the F1 score and hypertension decreasing with healthy exercise behaviors. However, the age × exercise habits interaction effect, not significant in the regression analysis, became significant ($P<.05$), showing a more pronounced effect of age on blood pressures and hypertension among women with poorer (unhealthy) exercise habits.

DISCUSSION AND CONCLUSION

Three basic objectives of this research were to examine: 1) the association of migration history and health behaviors; 2) the association of health behaviors and cardiovascular disease risk factor variables (CDRFVs); and 3) the combined effect of migration history and health behaviors on CDRFVs. For all of these analyses, the possible effects of age, social class and family stress were considered as potential intervening or moderating variables.

Before reporting the conclusions of hypotheses tested in relation to these 3 objectives, it would be worthwhile to discuss some general implications of the described results. First, in a multi-dimensional study such as this one, as expected, several subjects failed to provide valid information on a number of items in all categories of variables. However, as described in the methodology section, non-respondents did not introduce systematic bias in the marginal distribution of any variable. We maximized the number of observations to construct the composite variables such as MHS and family stress by defining averages over available information on relevant variables per subject. Since the cardiovascular disease risk factor variables (CDRFVs) were the ultimate set of dependent variables, however, the 3 factor scores of these variables were derived from the subjects with complete data on all 7 CDRFVs (only 3 subjects had missing data for this set of variables, in any case). Therefore, we contend that the results described used a data analysis design that maximized the number of observations without introducing any non-respondent bias to data gathered in the baseline survey of the "Unidos en Salud" project. Second, in relation to the dependence of MHS on SES and family stress, our observation of a positive correlation of MHS and SES, and a negative correlation between MHS and family stress (Table 4), can be regarded as support for a simple acculturation model,[41] suggesting that migration history is linearly related (negatively) with family stress and positively with SES. Any impact of migration history on health behavior change should be studied in relation to these observations. Third, data presented in Figure 1 imply that the influence of MHS on healthy exercise behaviors was different for the younger and older women, though this was not directly observed in the logistic regression analyses. ANOVA results of the categorical data (2 age categories $\times$ 2 exercise classes $\times$ 3 migration history classes) demonstrated that MHS and MHS $\times$ age interaction effects were significant ($P<.001$ and $P<.05$, respectively), while the main effect of age was not. Thus, even though age, *per se,* did not influence healthy exercise behavior, the effect of migration history on healthy exercise behavior was different for younger and older women. Fourth, analyses shown in Table 6 imply that all 3 cardiovascular disease risk factors increased with age; however, the relationship of cardiovascular disease risk with MHS and healthy exercise behavior was restricted to blood pressures alone.

Conclusions for Test of Hypothesis 1

Migration history was associated with both SES and family stress in Mexican-American women. Such changes were independent of age; those with a higher migration history score had higher SES and lower family stress, irrespective of age. When age was taken into account, however, health behaviors were unequally influenced by migration history. Healthy exercise behavior deteriorated with higher MHS in older women; in younger women, the relation between healthy exercise and MHS was non-linear, with exercise habits deteriorating from recent to intermediate, and improving subsequently among those with the highest category of MHS. While no other health behavior was influenced by MHS, healthy sleeping and drinking habits improved with age in these Mexican-American women. Therefore, in relation to the hypothesis of the first objective of this study, the following conclusion can be reached: With a higher score of MHS, the exercise habits of the Mexican-American women changed toward 'unhealthy,' and this migration-history related health behavior change was not mediated or moderated by SES, and family stress. With older age, women had healthier drinking and sleeping habits, independent of migration history. Even though age, per se, did not influence healthy exercise behavior, the relationship of MHS and healthy exercise behavior was different in younger (≤45 years) and older (>45 years) women (Figure 1).

Conclusions for Test of Hypothesis 2

In relation to the second objective, the data (see Table 6) supported the hypothesis: Healthy exercise habits were inversely related to the cardiovascular disease risk factor of high blood pressures, independent of age, SES, and family stress. However, all CDRFVs increased with age. These conclusions remained unaltered when WHR was considered as an additional predictor of the cardiovascular disease risk factors.

Conclusions for Test of Hypothesis 3

Data analysis for the third objective supported the hypothesis: Blood pressures (F1) increased with higher MHS. However, this association was mediated by the cardiovascular disease risk reducing effect of healthy exercise behaviors. In other words, the significant positive association of blood pressures with MHS was an indirect consequence of the deterioration of healthy exercise behaviors in women with a higher MHS, and of the positive influence of healthy exercise behaviors in reducing blood pressures. This relationship of migration history and exercise habits was independent of age, which by itself increased blood pressure.

Age as a Moderator of the Effects of Migration History on Healthy Exercise Habits

Baron and Kenny[42] defined a moderator variable as: 1) initially uncorrelated with both predictor and criterion (dependent) variables; and 2) in interaction with the predictor, significantly related to the criterion variable. In relation to the effects of migration history (MHS) on healthy exercise behaviors, age mildly satisfied these criteria. Data shown in Table 4 demonstrate that age was not correlated with either MHS or exercise behaviors. The regression effect on healthy exercise behavior was also not significant. Although age $\times$ MHS interaction effect was not significant (at 5% level) when taken as a continuous variable in the logistic regression model for exercise habits, discrete treatment of age (2 classes) and MHS (3 classes) showed a somewhat different result (Figure 1). The effect of MHS on exercise habit in younger women was non-linear; exercise behaviors worsened from recent to intermediate class of MHS, and subsequently improved for long-term class of MHS, while in older women a more linear decline was seen. Thus, age may be considered as having a mild moderating effect on the relationship of MHS on exercise habits. As might be expected, the younger Mexican-American women, in comparison with the older ones, may have a different set of social and cultural circumstances relating to their migration history, which possibly affect their differential health behaviors, thus explaining the trend seen in this data. Larger family sizes and the resulting greater household workload of older women may also have contributed to their lack of involvement in calorie-burning vigorous exercise behavior. Since family size was not recorded, however, this possibility could not be directly examined.

The cardiovascular disease risk variables (CDRFVs) scores were, as expected, directly influenced by age. The only interaction effect observed was in an analysis that treated age as a dichotomous variable, in which a mild interaction of age with exercise was observed (Figure 2). The blood pressure reducing effect of healthy exercise was more prominent in older (>45 years of age) women, compared with younger (≤45 years). However, the main effect of age on blood pressures persisted.

The adverse effects of poor exercise habits may be cumulative over time and may therefore have appeared more prominent in older women.[43–46] There were no data indicating the length of time the women had been adhering to the health habits reported in the 7-day recall survey. There are suggestions of such moderating effects of age in the literature as well. Although Cantero et al only studied migration history in relation to health behavior change, they concluded that the effect of migration history on changes in health habits is less pronounced, and probably different, in older women (aged 65 years +), compared to younger women.[14] The present study involved women aged 65 years or younger, so a strict comparison with the previous study is not possible. In the present sample, increased age apparently accentuated the deteriorating effects of migration history on exercise behavior and the beneficial effects of exercise in reducing blood pressure.

Healthy Exercise Habits Mediate the Influence of Migration History on Blood Pressures

Baron and Kenny indicated that a mediating variable in a relation between a putative predictor and an outcome exhibit the following characteristics: 1) The presumed mediator is significantly related to an independent variable (eg, through a path labeled as *a*); 2) The presumed mediator should also be significantly related to the dependent variable (eg, path *b*); 3) When paths *a* and *b* are controlled, a previously significant relationship between the independent and dependent variables is diminished; and 4) A mediator is a variable which is changeable, and, therefore, a factor through which a health intervention could be influenced.[42] In the present analyses, healthy exercise behaviors completely satisfied these descriptions (Tables 4–7).

The logistic regression analysis of healthy exercise behaviors (Table 5) demonstrated that MHS had a significant regression coefficient ($\beta_{MHS} = -0.432 \pm 0.156$, $P < .01$) as a predictor. Therefore, a causal path, such as (*a*), may exist in the 3-way link of MHS, exercise behaviors, and blood pressures. Further, healthy exercise behaviors were negatively correlated (Table 4), and had significant negative regression coefficients as one of the multiple predictors of blood pressure (Table 6). This finding is consistent with the existence of a causal path, such as Baron and Kenny's *b* path.[42] Finally, when MHS and exercise habits were used jointly as predictors of blood pressure (together with age, in presence/absence of WHR), the contribution of MHS in the regression model was no longer significant (Table 7). In fact, the addition of healthy exercise habits in such regression models significantly improved the proportion of explained variance by the regression equation. This meets the third criterion of a mediator, as defined above. Therefore, the data supported the notion that healthy exercise habits play a mediating role in the relationship of MHS and chronic disease risk associated with blood pressure.

Although it was not a major focus of this study, our findings were consistent with the Mexican-American health paradox, as noted previously by Markides et al.[47] These researchers demonstrated that Mexican Americans (particularly males) have trends of cardiovascular risk factors as high as in other populations, but have lower rates of heart disease. In the present work, we also found that the overweight Mexican-American women of Starr County, in spite of being predominantly (72%) obese (ie, BMI exceeding 30 kg/m^2, see Table 3), had glucose, lipid, and blood pressure levels that were not generally elevated, as would have been expected. This is particularly noteworthy since nearly 72% of these women were also sedentary, and about 65% had fat-rich diets (Table 2).

Synthesis of Major Conclusions

A synthetic model of the 3-way interrelationship of migration history, health behavior, and chronic disease risk factors is proposed in Figure 3. Certain components of CDRFVs are affected by specific health behaviors, in a somewhat complex fashion. As discussed earlier, the cumulative effect of health behaviors, practiced over a certain period of life, may also influence the observed results (Figures 1 and 2). Therefore, intervention programs to reduce CDRFVs, cru-

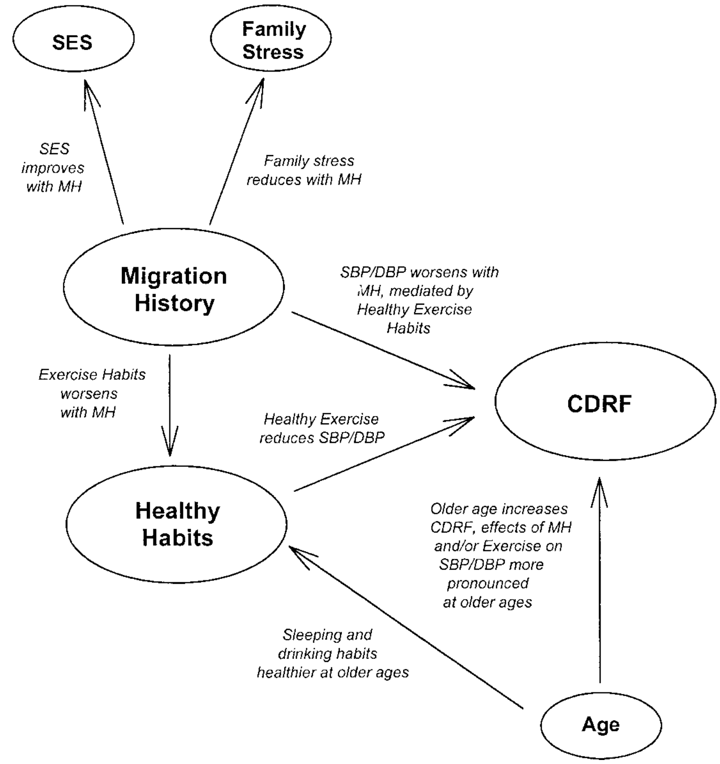

Fig 3. A path diagram representing the inter-relationship of migration history (MH), healthy habits (HH), and chronic disease risk factors (CDRF).

"Causal models, such as the one suggested here, can help to meet these challenges, since they would allow identification of the possible barriers to lifestyle changes."

cial to the long-term health of persons susceptible to chronic diseases, should be designed in view of the network of relationships, such as the one proposed here. Foreyt and Poston discussed some of the challenges for diet, exercise, and lifestyle modification in the management of obese individuals.[48] Causal models, such as the one suggested here, can help to meet these challenges, since they would allow identification of the possible barriers to lifestyle changes.

In this sense, the results of this study, as summarized in Figure 3, may offer some guidance. For example, data presented here showed migration history to be associated with less healthy blood pressures in overweight Mexican-American women; however, this appeared to be mitigated by healthy exercise behaviors. It could therefore be argued that health promotion activities targeted toward this population should include an exercise component, and should proceed with an understanding of what motivates some of these women to exercise. In addition, since smoking increased lipids, such health promotion programs should attempt to modify smoking behavior, although this is not associated directly with migration history (Table 4).

Age should also be considered in tailoring health promotion programs to this population. The effects of MHS on the health of Mexican-American women are somewhat different for older and younger women. Younger women scored higher on exercise than the older women, except for those classified as "recent" on the MHS scale (Figure 1). However, the usual effect of increasing blood pressures with age seemed to be mitigated by exercise (Figure 2). Therefore, it would be particularly important to determine ways to encourage older women to exercise. Our data also suggest that the motivating or facilitating factors of exercise promotion may differ in younger vs older women of different MHS classes. Finally, although the women of the present study were all overweight, there is no indication that these results are influenced by this criterion of the sample (Tables 5 and 6), thus enabling the above conclusions to be generalized to Mexican-American women living in other parts of the United States.

ACKNOWLEDGMENTS

This research constituted the DrPH degree project of the first author (BMC) at the School of Public Health of the University of Texas Health Science Center at Houston, Texas. Data analyzed were collected during the project "Unidos en Salud: Weight Loss for Mexican Americans," funded by NIDDK grant R18-HL47082 (to JPF) from the US National Institutes of Health. We thank Ms. Nancy L. MacNoughton for data coding, and Dr. Yixi Zhong for preparing the graphic display of data. Two anonymous reviewers also made several constructive suggestions that improved the presentation of this work.

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