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Physical Activity and Cardiovascular Health in Aging Women: A Health-Promotion Perspective

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Cardiovascular disease is the leading cause of death in women. The purpose of this study was to explore the relationship between physical activity and other determinants of cardiovascular health in aging women from a health-promotion perspective. Participants ($N = 206$) completed a cardiovascular health-promotion profile, and various physical measures were recorded. The findings suggest that physically active aging women, especially those who exercise regularly or vigorously, have healthier cardiovascular profiles than do their less active counterparts. They were more likely to be members of a health and fitness facility, to be younger, and have higher socioeconomic status. Their diets were healthier, and their perception of their health status was more positive. Physical measures of cardiovascular health also decreased with increased levels of activity ($p < .05$). These findings validate physical activity promotion as an effective strategy to ameliorate the cardiovascular health profile of aging women. The study also lends support for population-based cardiovascular health-promotion strategies.

Key Words: cardiovascular disease, health determinants, women's health

Despite a declining trend over the past several decades, cardiovascular disease (CVD) remains the leading cause of mortality for both men and women throughout the industrialized world. Thirty-nine percent of all deaths in Canadian women are attributed to CVD, which is more than all cancers combined (Statistics Canada, 1997). Although men are more vulnerable to CVD after the age of 35, women appear to be protected until around the age of menopause. For both sexes, however, there is a dramatic increase in cardiovascular-related mortality in the later years. Compounding this problem is a growing aging population. The baby-boomer generation is getting older, and both men and women are living longer. Hence, the proportion of seniors in the population is increasing and is expected to continue to escalate over the next several decades. It follows that this "demographic transition" (Restrepo & Rozental, 1994) will have a significant impact on the incidence and prevalence of CVD in the next several decades. Therefore, it is of paramount importance to determine ways to enhance the cardiovascular health of aging women and thus increase their chances of living a long and healthy life.

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Notwithstanding the magnitude of the problem, CVD in women has, until recent years, been virtually ignored (Manolio & Harlan, 1993). Women have been "under-represented in clinical trials, including those evaluating risk factor modification as a means to prevent or to decrease the progression of atherosclerotic cardiovascular disease" (Kitler, 1994, p. 411). In a review of cardiovascular-related clinical trials published between 1960 and 1990, Gurwitz, Col, and Avorn (1992) found that only 20% of the studies that provided information on the gender of participants included women. In addition, the aging population is often excluded from studies because of small numbers or logistical problems (Wenger, 1996).

Similarly, most epidemiological research has "tended either to exclude women systematically because of their relatively low endpoint rates, or to follow insufficient numbers of women to permit reliable estimates of CHD risk" (Wenger, 1996, p. 389). Thus, the broader determinants of cardiovascular health and disease in men are often generalized to women, and the unique aspects of aging women's health risks in particular are overlooked. For example, although the positive relationship between income and health is well established, the fact that more than half the total population with low incomes in Canada is made up of women—single senior women, in particular—is often forgotten. Given that CVD is more prevalent in households with annual incomes of less than $25,000 (Reeder, Liu, & Horlick, 1996), it follows that women would be especially vulnerable to this health problem.

Sedentary living has been linked to a variety of health-related problems, including CVD. It is estimated that one third of deaths related to CVD are the direct result of physical inactivity (Francis, 1996). Unfortunately, however, sedentary living is a widespread problem throughout North America. According to recent statistics, less than 40% of Canadians are active at a level sufficient to derive substantial heart and other health benefits (Russell & Craig, 1996). Specific to this study, 68% of Canadian women are reportedly inactive, as compared with 59% of men (Canadian Fitness and Lifestyle Research Institute, 1999). Participation in sports also continues to be dominated by men.

Previous cardiovascular research has generally focused on individual risk factors rather than an overall population health perspective. Also, there is a dearth of research evidence linking physical activity to the broader determinants of cardiovascular health, particularly in aging women. The population health-promotion model (Bhatti, 1996; see Figure 1) combines the philosophies of health promotion and population health into a "powerful and pragmatic alliance" (Bhatti, p. 32). This three-dimensional model includes the comprehensive strategies for health promotion described in the *Ottawa Charter for Health Promotion* (World Health Organization, 1986), the broad determinants of population health, and the various levels in society where the action can be taken. Thus, this model illustrates "how a population health approach can be implemented through action on the full range of health determinants by means of health promotion strategies" (Bhatti, p. 38). Moreover, it reflects the importance of evidence-based decision making as a foundation for the development of population health-promotion activities (Bhatti). No previous cardiovascular research has used this framework. The purpose of this study, therefore, was to describe and explore the relationship between physical activity and the broader determinants of cardiovascular health in healthy aging women in the context of the population health-promotion model.

Figure 1. The population health-promotion model. From "Population health promotion: An integrated model of population health and health promotion" by T. Bhatti, 1996. In J. Feather and B. Sproat (Eds.), *Population health promotion: Bringing our visions together* (Conference Proceedings, Saskatoon, Saskatchewan) (p. 39). Ottawa: Health Canada.

Methods

STUDY DESIGN

A cross-sectional, comparative survey design was used to address the primary research hypothesis that there is a positive relationship between physical activity and the broader determinants of cardiovascular health in healthy aging women.

Participants were recruited at a health and fitness facility in Winnipeg, Manitoba, Canada. To ensure heterogeneous patterns of physical activity, each member of the facility was asked to recruit a similar-age, nonmember friend to participate in the study. This "snowball" sampling strategy was also used because relative socioeconomic homogeneity was integral to other aspects of the study. Data-collection sessions, including the completion of the questionnaires and physical measures, were held at the fitness facility. The University of Manitoba Faculty of Medicine Ethical Review Committee approved the study protocol, and all subjects signed a statement of informed consent before participation.

PARTICIPANTS

A convenience sample of 206 women between the ages of 35 and 74 (*M* = 54 years), self-described as healthy (no previous history of CVD, hypertension, diabetes, or cancer) and with no physical restrictions to activity, participated in the study. This sample size provided sufficient power to detect a medium-sized effect of physical activity on the broader determinants of cardiovascular health (Hassard, 1991). The demographic characteristics of the study cohort are outlined in Table 1. Approximately 60% of the women were employed, and of those, almost 80% worked full time. A large percentage of the sample were married, were employed (previously or currently) as professionals or executives, and had college certificates or university degrees. Although there was considerable variation in the women's incomes, over 50% reported combined family incomes between $25,000 and $64,000, and 45%, $65,000 or more per year.

PSYCHOMETRIC MEASURES

Cardiovascular Health Promotion. A review of the research literature elicited a comprehensive inventory of factors that affect the cardiovascular health of aging women. These factors were categorized within the broader determinants of population health and subsequently operationalized in a survey questionnaire, the Cardiovascular Health Promotion Profile (CVHPP), and a demographic form. To ensure face and content validity, the CVHPP questionnaire was reviewed by a panel of experts and pretested on a sample of 13 women.

The Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1983) was incorporated in the CVHPP as a broad indicator of the ability to cope with stressful situations. The rationale for including this instrument was based on the hypothesis that "the relationship of psychosocial stress to coronary disease depends on the meaning of the situation to the individual and the way she perceives her own life situation" (Elliott, 1995, p. 105). Reliability and validity of the Perceived Stress Scale have been established in previous research (Cohen et al.; Gotlib, Whiffen, & Mount, 1991).

Physical Activity. Paffenbarger's physical activity questionnaire (PPAQ; Paffenbarger, Wing, & Hyde, 1978; Pereira et al., 1997) was integrated into the CVHPP to measure various aspects of physical activity in the study cohort. Test–retest reliability of the PPAQ has been well established in a variety of cohorts including women (Pereira et al., 1997). In validation studies, correlation coefficients with specific fitness measures, as well as other activity questionnaires, are generally affirming (Pereira et al.). Moreover, there is convincing evidence of a relationship between the PPAQ and risk factors for CVD, the incidence of coronary heart disease, and all-cause mortality (Cauley, LaPorte, Black-Sandler, Schramm, & Kriska, 1987; Owens, Matthews, Wing, & Kuller, 1990; Paffenbarger, Wing, Hyde, & Jung, 1983; Washburn, Smith, Goldfield, & McKinlay, 1991). This instrument also acknowledges the importance of structured exercise, as well as energy expended related to activities of daily living.

To complete the data set of cardiovascular health determinants, demographic information was also elicited. Also, physical measures including resting heart rate, blood pressure (BP), height, weight, and waist and hip measurements were taken for each participant.

Table 1 Demographic Characteristics of the Cohort (*N* = 206)

Characteristic	Frequency	%
Employed	121	58.74
full-time	93	76.86
part-time	28	23.14
Not employed	85	41.26
retired	61	71.76
housewife	17	20.00
seeking employment	7	8.24
Occupation		
professional/executive	114	55.34
managerial/business owner	23	11.17
sales, clerical, secretarial	56	27.18
craftsman, operator, laborer, service worker	11	5.34
other (including homemaker)	2	0.97
Education		
<Grade 12	5	2.43
high school graduate	40	19.42
technical school/college or university certificate/degree	135	65.53
master's/doctorate	26	12.63
Marital status		
single	20	9.97
married/common-law relationship	147	71.36
widowed	17	8.25
separated/divorced	22	10.68
Family income (*n* = 200)		
<$25,000	7	3.50
$25,000–44,000	49	24.50
$45,000–64,000	55	27.50
$65,000–84,000	31	15.50
$85,000–104,000	25	12.50
>$104,000	33	16.50

Physically active aging women were hypothesized to have healthier cardiovascular health profiles in the context of the socioeconomic (i.e., income and social status, employment status, and education), behavioral (i.e., personal health practices and coping skills, social support, and health services) and biologic (i.e., age, BP, resting heart rate, and obesity) determinants of health.

DATA ANALYSIS

The data were initially analyzed with a number of bivariate methods including correlational analyses (Pearson's *r* product–moment and Spearman's rank), analysis of variance (ANOVA), and chi-square tests. Because of the numerous questions and variables involved, however, multivariate methods were central to the data analyses. To this end, physical activity was treated as the outcome variable and operationalized from several perspectives. Total number of kilocalories expended in physical activity per week was a composite index (Pereira et al., 1997) of structured physical activity (i.e., exercise: activity MET intensity × occasions per week × duration in minutes per occasion × weeks of activity per year ÷ 52 weeks per year), plus lifestyle activity (number of blocks walked and the number of stairs climbed, as a part of activities of daily living, in the average week: [blocks per day × 7 days per week × 8 kcal per block] + [flights of stairs per day × 7 days per week × 4 kcal per flight]). This variable was analyzed as a continuous (multiple and stepwise regression), ordinal (ANOVA and ANCOVA), and categorical (logistic-regression and discriminant-function analyses) variable.

Because the composite index does not specifically address these dimensions of structured activity, participants were also asked whether they exercised regularly (at least three times a week for 20 min) or vigorously (at least once a week, regular activity akin to brisk walking, jogging, bicycling, swimming—long enough to work up a sweat, get heart thumping, or get out of breath). As categorical data, these variables were analyzed with discriminant-function and logistic-regression analyses. Because the various measures of activity were potentially highly correlated, the threat of multicollinearity was addressed throughout the analysis procedures. When feasible, highly correlated variables (≥.80) were not entered in the same data analyses. In analyses in which the independent influence of two highly correlated variables was required, a multicollinearity report was generated. This report was based on the calculation of a variance inflation factor ($1/[1 - r^2]$), with high values (≥10) indicating a likely problem (Hintze, 1998).

Results

PHYSICAL ACTIVITY

Sixty-six percent of the cohort (135 of the 206 participants) were members of the health and fitness facility. Overall, the cohort was very active, with 80% of the women reporting that they exercised regularly or vigorously. On average, participants exercised for 45 min/day and expended 1,500 kcal/week in structured, and 900 kcal/week in lifestyle, activity. The most common form of exercise reported by the women was walking (66% reported walking specifically for the purpose of exercise), followed by cycling, weight training, and aerobics.

Table 2 summarizes the results of the stepwise regression analysis, with physical activity as a continuous variable (total kilocalories expended in physical activity per week) and affirms the intimate relationship between the various forms of activity. The findings reflect that the women who were more physically active—that is, those who expended more kilocalories exercising, as well as climbing stairs and walking as a part of their daily lives—also tended to expend more kilocalories overall and were more likely to exercise regularly or vigorously.

Table 2 Stepwise Regression Analysis: Total Kilocalories of Physical Activity per Week

Step	Variable added	R^2 increment	Final *t*	*p*
1	Exercise regularly[a]	.192	4 .44	.00002
2	Total kcal expended per week[b]	.125	5.53	0
3	Age	.036	–2.89	.004
4	Perceived health status	.029	2.12	.03
5	Exercise vigorously[c]	.042	2.03	.04
6	Watch diet	.018	–2.5	.01
7	Dietary fat intake	.017	–2.32	.02
8	Income	.016	2.28	.02

Note. Model R^2 = .445.
[a]Exercise at least 3 times/week for 20 min. [b]Composite index of total overall kilocalories expended per week, including sleeping/reclining, sitting, and light, moderate, and vigorous activity. [c]Regular activity akin to brisk walking, jogging, bicycling, or swimming, long enough to work up a sweat, get heart thumping, or get out of breath.

PHYSICAL ACTIVITY AND CARDIOVASCULAR HEALTH DETERMINANTS

Tables 2 and 3 highlight the results of data analyses of the relationship between physical activity and the broader determinants of cardiovascular health. These analyses provide convincing evidence of a relationship between income and physical activity. An additional analysis (ANCOVA, controlling for age and marital status) lent further support for the relationship between these variables ($p = .02$). There was no significant relationship between physical activity and education or any of the employment-related analyses (i.e., employment status, occupation). Although the simple regression analyses did suggest a positive relationship between physical activity and social support ($p = .04$), controlling for possible confounding variables in the multivariate analyses refuted this hypothesis. Similarly, although 75% of the women who expended more than 2,000 kcal/week in physical activity were married, marital status did not emerge as a significant influencing factor on level of activity.

The biological determinant was operationalized with several components (see Table 4). Significant trends, based on increasing levels of physical activity, included a decrease in resting heart rate, body-mass index, and waist measurement (see Table 3). Although the relationship between waist:hip ratio and activity did emerge as significant in the stepwise logistic-regression analysis (waist:hip ratio <.8 vs >.8; $p = .03$), neither regular nor vigorous activity had a direct influence on this measure of obesity. Conversely, both regular and vigorous activity had a significant effect on waist measurement ($p = .009$ and .01, respectively) and body-mass index ($p = .03$ and .03, respectively).

Table 3 Determinants of Cardiovascular Health and Physical Activity Levels (kcal/wk): Simple Comparisons of the Null Hypothesis (ANOVA or chi-Square Tests)

	Physical Activity Levels (kcal/wk)					
Determinant	<1,000 (*n* = 36)	1,000–1,999 (*n* = 70)	2,000–2,999 (*n* = 41)	≥3,000 (*n* = 59)	*F* or χ^2	*p*
Income (*M* ± *SD*), 1 = <\$25,000 to 6 = ≥\$104,000	3.0 ± 1.35	3.6 ± 1.45	3.5 ± 1.38	4.0 ± 1.57	*F* = 3.47	.02
Biology and Genetic Endowment						
Age (*M* ± *SD*)	54.6 ± 9.9	55.8 ± 9.7	56.4 ± 10.6	49.9± 9.5	*F* = 4.91	.002
Blood pressure (*M* ± *SD*)						
systolic	133 ± 15.7	126 ± 17.1	132 ± 23.6	122 ± 16.7	*F* = 4.05	.008
diastolic	83.0 ± 8.9	80.5 ± 9.36	82.7 ± 10.21	77.2 ± 7.48	*F* = 4.67	.003
mean	100 ± 9.6	96 ± 11.2	99 ± 13.7	92 ± 10.0	*F* = 5.53	.001
Resting heart rate (*M*)	71	69.8	69.4	65.9	*F* = 2.66	.049
Obesity						
body-mass index (*M* ± *SD*)	27.7 ± 5.0	25.9 ± 5.27	24.9 ± 3.61	24.6 ± 3.58	*F* = 3.62	.01
waist measurement (*M* ± *SD*)	0.813 ± .072	80.7 ± 11.1	80.1 ± 9.9	77.7 ± 7.87	*F* = 4.82	.002
Personal Health Practices/Coping Skills						
Perceived health status (*M* ± *SD*)	3.03 ± 0.29	3.23 ± 0.57	3.46 ± 0.50	3.52 ± 0.57	χ^2 = 31.25	.00002
Fat intake (*M* ± *SD*)	1.80 ± 0.58	1.53 ± 0.56	1.54 ± 0.50	1.44 ± 0.50	χ^2 = 13.61	.03
Diet factor (% high/positive)	30	47	56	61	χ^2 = 9.15	.03
Membership status (% members)	36	67	78	73	χ^2 = 18.13	.004

Table 4 Operationalizing the Determinants of Cardiovascular Health in Women

Determinant	Variable
Income and social status	household income
Social-support networks	social support, marital status
Education	level of education
Employment and working conditions	employment status, type of employment
Physical environment	N/A[a]
Biology and genetic endowment	family history of CVD, gender (controlled), hypertension, age, diabetes (controlled), hyperlipidemia, obesity, menopausal status, use of hormones
Personal health practices and coping skills	diet, smoking history, alcohol consumption, medications, physical activity, coping skills
Healthy child development	N/A[a]
Health services	utilization patterns

[a]Not addressed in this study.

The multiple-regression (see Table 2) and ANOVA (see Table 3) analyses lent support for an inverse relationship between age and activity; however, it is important to note that this relationship was nonlinear. A similar nonlinear trend was evident between levels of activity and systolic and diastolic BP (see Table 3). Controlling for age and waist measurement in an ANCOVA analysis resulted in a nonsignificant relationship between activity level and BP. Although the relationship between vigorous exercise and diastolic (but not systolic) BP was consistently significant (p = .03) in the various analyses, the relationship between regular exercise and BP was nonsignificant throughout.

The relationship between physical activity and personal health practices and coping skills was also explored with a number of variables (see Table 4). The women who were more active consumed significantly less fat in their diets and had healthier dietary beliefs and actions overall. Although health- and fitness-club membership status did not emerge as significant in the regression analysis (see Table 2), the chi-square analysis did support the contention that members were more active (see Table 3). Also, it is important to note that removing the activity variables from the regression model resulted in membership status emerging as significant (p = .0005). The women who reportedly exercised regularly or vigorously had lower perceived-stress scores ($p < .05$). The women with positive perceptions of their own health status were more physically active and more likely to exercise vigorously.

Discussion

PHYSICAL ACTIVITY

The women in this study were more active than their counterparts in the general population. According to the National Population Health Survey of 1994/95 (Johansen, Nargundkar, Nair, Taylor, & El Saadany, 1998), 36% and 33% of Canadian women between the ages of 35 and 64 and older than 64, respectively, were physically active. More specifically, the average energy expenditure of this cohort was above that previously reported for middle-aged premenopausal (1,408 kcal/week) and postmenopausal (1,118 kcal/week) women but not that for a younger cohort of female college students (3,318 kcal/week; Adams, LaPorte, Haile, & Kuller, 1986; Cauley et al., 1987; Owens et al., 1990). Although there are likely numerous explanations, it would appear that a significant factor in this "activity advantage" of the study cohort is their socioeconomic advantage.

Walking was the most popular form of exercise in the study cohort. This concurs with reports in the scientific literature that there is currently a high population prevalence of walking as a part of lifestyle, as well as for exercise (Siegel, Brackbill, & Heath, 1995). In a review of eight national surveys, including two from Canada, Stephens, Jacobs, and White (1985) found that walking was the most frequently reported physical activity. Evidence from more recent epidemiological data (Eaton, Nafziger, Strogatz, & Pearson, 1994; Siegel et al.) coincides with the earlier findings. Moreover, in a review of 11 clinical trials, Hillsdon and Thorogood (1996) found that walking was the prescribed mode of exercise in half the investigations, with more consistent and sustained increases in physical activity, when compared with controls. This suggests that walking might have a higher adherence rate than other forms of exercise and thus might also explain the higher prevalence of walking. Further research, especially population-based evidence, is needed to prove or refute this hypothesis.

Although walking is not without risks (Ready et al., 1999), the main reasons for its popularity are that it requires little skill and training and the cost is minimal. In a recent review that focused on the health benefits of walking, Shephard (1997) cited walking as having a beneficial influence on various indicators of good health, especially for the sedentary, the obese, and the elderly. Moreover, according to Shephard, walking "seems to yield important functional gains in the frail elderly" (p. 279). Specific to women, previous research has demonstrated that moderate-intensity walking is associated with cardiovascular health benefits (Duncan, Gordon, & Scott, 1991; Ready et al., 1996). Hence, health-promotion programs and policies should focus on encouraging walking in healthy, aging women.

PHYSICAL ACTIVITY AND CARDIOVASCULAR HEALTH DETERMINANTS

Although the findings of a significant relationship between income and activity concur with those of previous research (Dishman, Sallis, & Orenstein, 1985; Kaplan, Lazarus, Cohen, & Leu, 1991; Stephens et al., 1985; Yeager, Macera, &

Merritt, 1993), our findings are particularly convincing, given the relative socioeconomic homogeneity of the study cohort. The suggestion of a linear trend in the income–activity relationship (even after controlling for age) supports the hypothesis that cost might well be a relevant reason for not exercising. Women with higher incomes might also be more knowledgeable about, and have better access to, health-related information. These findings reinforce the importance of improving access to and the appeal of exercise facilities, particularly for lower income and older women. Also, women must be informed of the cardiovascular health benefits of low-cost activities such as walking.

Although the scientific literature is fairly consistent in providing convincing evidence that physical activity is associated with socioeconomic status in general, there is some disparity related to education. In this study, the educational achievements of the cohort were markedly skewed, with the majority of participants being educated beyond the high school level (see Table 1). This skewedness might explain why there was minimal evidence to support a relationship between education and physical activity. Also, it has been suggested that "the health effects of education, which likely include health knowledge, beliefs, self-care practices, and patterns of heath care utilization may also decrease with age" (Wister, 1996, pp. 469–470). This might explain the nonsignificant results in this aging cohort.

Evidence from previous research suggests that employment status influences patterns of physical activity (Stephens et al., 1985; Health and Welfare Canada, 1990). The nonsignificance of this relationship in our study might also be explained by small cell sizes. Also, the strength of the relationship between employment status and income ($p = .0001$) suggests that the relationship between employment and physical activity might have been explained by proxy. Thus, the findings related to the socioeconomic determinants of health affirm the value of addressing population, as well as individual, factors when planning strategies for promoting cardiovascular health in aging women.

The significance of the relationship between activity and social support concurs with the findings of others (Kaplan et al.,1991; Unger & Johnson, 1995). Although not statistically significant, the results also suggested that the more active women were more likely to be married. The less than convincing nature of these relationships might be explained by age: The older women in this study were reportedly less active, were less likely to be married, and reported significantly less social support than their younger counterparts did. Being part of a social milieu, perhaps accompanied by some degree of peer pressure, might reinforce the adoption and maintenance of healthy behaviors such as physical activity. To this end, strategies for promoting cardiovascular health in the aging population should include avenues for increased social support.

Despite the cross-sectional nature of this study, there was considerable evidence to support a significant relationship between physical activity and the biological determinants of cardiovascular health. For example, the findings lend support for an inverse relationship between physical activity and age. This concurs with population-based evidence that physical activity is most common among the young and least common at older ages (Statistics Canada, 1991, 1995). Although the decrease in activity and fitness levels with age is greater for women than for men (Russell & Craig, 1996), the changing face of younger women's fitness might be the result of the growing sociocultural acceptance of athletic women that has occurred over the past several decades (Drinkwater, 1989). Thus, it is important to acknowledge that "many older women were raised in an era when vigorous exercise was not recommended for women" (Taunton et al., 1997, p. 8). Dishman (1994) also cites activity limitations, lack of knowledge of the health benefits of physical activity, limited access, and less perceived control over exercise and health as barriers to physical activity in the aging population. It follows that strategies for promoting physical activity in aging women should be developed in the context of these issues.

The inverse relationship between resting heart rate and physical activity was supported in the bivariate but not the multivariate analyses. The contention that resting heart rate is influenced more by body size than by physical activity was supported by the finding that, after controlling for waist measurement, the relationship between physical activity and resting heart rate was nonsignificant. It is important to acknowledge, however, that there might be a circuitous relationship between physical activity and resting heart rate because of the effect of activity on body size.

Although it is generally accepted that a lower resting heart rate is the outcome of physical fitness, the findings of this study suggest that it might not be as useful in the study of physical activity. Nonetheless, it is also important to acknowledge that our "snapshot" data-collection procedures might not have effected a true resting heart rate. Repeated measures and a larger sample size, as well as prospective evidence, would undoubtedly provide further insight into this relationship.

Although known hypertension was an exclusion criterion for participation in the study, there was considerable variation in BPs within the cohort. Our findings of a significant inverse relationship between BP and physical activity has been observed in previous studies of men (Paffenbarger et al., 1983), as well as women (Gibbons, Blair, Cooper, & Smith, 1983; Owens et al., 1990; Reaven, Barrett-Connor, & Edelstein, 1991). The evidence of a significant relationship between BP and vigorous but not regular exercise supports findings of previous research on men. In a longitudinal follow-up (6–10 years) of almost 15,000 male college alumni, Paffenbarger et al. (1983) reported a significantly lower risk of hypertension (35%) in those who exercised vigorously but no significant influence on risk for those who climbed stairs, walked, or participated in light sports. In a subsequent follow-up of the same cohort, Paffenbarger and associates (1993) found that those who maintained or established patterns of moderately vigorous sports activity had a significantly lower risk of death related to CVD. The prospective follow-up of the current study cohort will provide further insight into the activity–CVD relationship in aging women.

Our findings also lend support for the consistent research evidence of a significant inverse relationship between body composition and amount of physical activity in both men and women (Gibbons et al., 1983; Owens et al., 1990; Tremblay et al., 1990). The marked decrease in waist measurement with increasing levels of physical activity is particularly relevant in view of the recent attention to visceral obesity as a predictor of CVD. Given that obesity carries a significant risk for CVD, the findings of this study would support the promotion of regular, as well as vigorous, activity to reduce this particular risk factor in healthy, aging women.

Small cell sizes might explain the nonsignificant results related to a number of the personal health practice variables (medication intake, smoking, and alcohol consumption). Consistent with the findings of others (Johnson, Nichols, Sallis, Calfas, & Hovell, 1998; Tapp & Goldenthal, 1982), however, there was a significant relationship between dietary factors and physical activity. Further prospective research is central to establishing the direction of this relationship. The significance of the relationship between activity and health- and fitness-facility membership also concurs with previous research (Hurrell, 1997). Access to exercise equipment and structured fitness and exercise classes, as well as the benefits afforded by the social milieu, are logical contributing factors to these results.

The significance of the relationship between regular or vigorous physical activity and perceived stress, as well as perceived health status, suggests that women who are physically active feel better about themselves and their lives in general. Although the literature is replete with reports on the psychological health benefits of exercise, the type of activity required to achieve this effect has not been established. The implication of our findings is that planned regular and intense exercise might be more important than the total amount of physical activity in managing stress. Because of the cross-sectional nature of this study, the direction of the relationship between activity and personal health practices and coping skills cannot be ascertained. Although this is a study limitation, the planned prospective extension of the study will undoubtedly provide insights into this and other directional relationships.

Conclusion

This study provides substantial support for the hypothesis that physically active aging women, especially those who exercise regularly or vigorously, have healthier cardiovascular profiles than do their less active counterparts. The complexity of the various relationships reinforces the importance of considering the determinants of cardiovascular health as a whole, rather than only in the context of each risk factor in isolation. Therefore, strategies for promoting cardiovascular health in general, and physical activity in particular, should be developed in the context of population health and a framework such as the population health-promotion model.

At the individual level, it is important to nurture the personal skills of aging women so that they can realize a greater sense of self-efficacy, as well as mastery and control over their own health. According to the *Ottawa Charter* (World Health Organization, 1986), an enabling approach to personal and social development should include strategies to improve knowledge about health and the enhancement of life skills. In theory, this facilitates an increased sense of control over one's health and the ability to make healthy choices. Thus, knowledge is a common thread throughout the various influencing factors involved in promoting a healthy lifestyle. For example, it is unlikely that individuals will change their behaviors if they are unaware of the consequences of maintaining those behaviors—"A key motivator for behavioral change is the perceived threat posed by existing behaviors and the perceived severity of the consequences of those behaviors" (Reid, 1995, p. 26A). Hence, education is central to the promotion of health, in general, and cardiovascular health, in particular.

Community-level interventions play an important role in providing the access and information necessary to enable women to achieve the goal of cardiovascular health. It is important to involve and mobilize the community to create an environment that will support the adoption and maintenance of positive health behaviors. To this end, the workplace provides an ideal setting for cardiovascular health-promotion initiatives because the number of employed women, of all ages, has increased so dramatically over the past 2 decades. This is especially true for the many working women with caregiving responsibilities, because finding (or making) the time to learn about and participate in these initiatives is often difficult.

At the systemic/societal level, a key health-promotion strategy is advocating healthy public policies. For example, policies that focus on deficit reduction and private-sector economic growth can be unhealthy for the population because they tend to increase economic inequalities (Canadian Public Health Association, 1996). Such policies are particularly devastating for women. Hence, the Canadian Public Health Association proposes that "we need to give more emphasis to policies that create healthy living conditions and work to ensure that the voices of society's least powerful express their concerns in these policy issues" (p. 2). Also, policies related to resource allocation must shift to reflect the reorientation of health services from health *care* to health *promotion*.

Finally, in the research arena, further studies with larger sample sizes and prospective designs are central to unraveling the mystery of cardiovascular health promotion in aging women. A significant contribution of this investigation was its unique approach to organizing and building on existing knowledge related to cardiovascular health and disease in aging women in the context of a health-promotion perspective. The evidence suggests that the population health-promotion model is an efficient and effective means of addressing the broad range of cardiovascular health determinants, including physical activity. Thus, a pivotal foundation for future research in this area has been established.

References

Adams, L.L., LaPorte, R.E., Haile, G.T., & Kuller, L.H. (1986). Sex difference in high-density lipoprotein cholesterol and subfractions among young black adults. *Preventive Medicine,* **15**, 118-126.

Bhatti, T. (1996, February). Population health promotion: An integrated model of population health and health promotion. In J. Feather & B. Sproats (Eds.), *Population health promotion: Bringing our visions together. Conference proceedings, Saskatoon, Saskatchewan* (pp. 33-47). Ottawa: Health Canada.

Canadian Fitness and Lifestyle Research Institute. (1999). *1999 physical activity monitor*. Retrieved July 23, 2002, from http://www.cflri.ca/cflri/pa/surveys/99survey/99survey.html

Canadian Public Health Association. (1996). *Action statement for health promotion in Canada*. Ottawa: Canadian Public Health Association.

Cauley, J.A., LaPorte, R.E., Black-Sandler, R., Schramm, M.M., & Kriska, A.M. (1987). Comparisons of methods to measure physical activity in post-menopausal women. *American Journal of Clinical Nutrition,* **45**, 14-22.

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior,* **24**(12), 385-396.

Dishman, R.K. (1994). Motivating older adults to exercise. *Southern Medical Journal,* **87**(5), S79-S82.

Dishman, R.K., Sallis, J.F., & Orenstein, D.R. (1985). The determinants of physical activity and exercise. *Public Health Reports,* **100**(2), 158-171.

Drinkwater, B.L. (1989). Assessing fitness and activity patterns of women in general population studies. In T.F. Drury (Ed.), *National Center for Health Statistics* (DHHS Publication No. 89-1253, pp. 261-271). Washington, DC: U.S. Government Printing Office.

Duncan, J.J., Gordon, N.F., & Scott, C.B. (1991). Women walking for health and fitness: How much is enough? *Journal of the American Medical Association,* **266**(23), 3295-3299.

Eaton, C.B., Nafziger, A.N., Strogatz, D.S., & Pearson, T.A. (1994). Self-reported physical activity in a rural county: A New York county health census. *American Journal of Public Health,* **84**(1), 29-32.

Elliott, S.J. (1995). Psychosocial stress, women and heart health: A critical review. *Social Science and Medicine,* **40**(1), 105-115.

Francis, K. (1996). Physical activity in the prevention of cardiovascular disease. *Physical Therapy,* **76**(5), 456-468.

Gibbons, L.W., Blair, S.N., Cooper, K.H., & Smith, M. (1983). Association between coronary heart disease risk factors and physical fitness in healthy adult women. *Circulation,* **67**(5), 977-983.

Gotlib, I., Whiffen, P., & Mount, J. (1991). Prospective investigation of postpartum depression: Factors involved in onset and recovery. *Journal of Abnormal Psychology,* **100**(2).

Gurwitz, J.H., Col, N.F., & Avorn, J. (1992). The exclusion of the elderly and women from clinical trials in acute myocardial infarction. *Journal of the American Medical Association,* **268**(11), 1417-1422.

Hassard, T.H. (1991). *Understanding biostatistics*. Toronto: Mosby Year Book.

Health and Welfare Canada. (1990). *Canada's health promotion survey 1990* (H39-263/2-1990E). Ottawa: Health and Welfare Canada.

Hillsdon, M., & Thorogood, M. (1996). A systematic review of physical activity promotion strategies. *British Journal of Sports Medicine,* **30**(2), 84-89.

Hintze, J.L. (1998). *Number cruncher statistical systems* (Version NCSS 2000). Kaysville, UT: NCSS.

Hurrell, R.M. (1997). Factors associated with regular exercise. *Perceptual and Motor Skills,* **84**, 871-874.

Johansen, H., Nargundkar, M., Nair, C., Taylor, G., & El Saadany, S. (1998). At risk of first or recurring heart disease. *Health Reports,* **9**(4), 19-29.

Johnson, M.F., Nichols, J.F., Sallis, J.F., Calfas, K.J., & Hovell, M.F. (1998). Interrelationships between physical activity and other health behaviors among university women and men. *Preventive Medicine,* **27**, 536-544.

Kaplan, G.A., Lazarus, N.B., Cohen, R.D., & Leu, D.J. (1991). Psychosocial factors in the natural history of physical activity. *American Journal of Preventive Medicine,* **7**(1), 12-17.

Kitler, M.E. (1994). Coronary disease: Are there gender differences? *European Heart Journal,* **15**(3), 409-417.

Manolio, T.A., & Harlan, W.R. (1993). Research on coronary disease in women: Political or scientific imperative? *British Heart Journal,* **69**(1), 1-2.

Owens, J.F., Matthews, K.A., Wing, R.R., & Kuller, L.H. (1990). Physical activity and cardiovascular risk: A cross-sectional study of middle-aged premenopausal women. *Preventive Medicine,* **19**, 147-157.

Paffenbarger, R., Wing, A.L., & Hyde, R.T. (1978). Physical activity as an index of heart attack in college alumni. *American Journal of Epidemiology,* **108**, 161-175.

Paffenbarger, R.S., Hyde, R.T., Wing, A.L., Lee, I-M., Jung, D.L., & Kampert, J.B. (1993). The association of changes in physical-activity level and other lifestyle characteristics with mortality among men. *New England Journal of Medicine,* **328**(8), 538-545.

Paffenbarger, R.S., Wing, A.L., Hyde, R.T., & Jung, D.L. (1983). Physical activity and incidence of hypertension in college alumni. *American Journal of Epidemiology,* **117**, 245-255.

Pereira, M.A., Fitzgerald, S.J., Gregg, E.W., Joswiak, M.L., Ryan, W.J., Suminski, R.R., et al. (Eds.). (1997). A collection of physical activity questionnaires for health-related research. *Medicine and Science in Sports and Exercise*, **29**(Suppl.), S1-S205.

Ready, A.E., Bergeron, G., Boreskie, S.L., Naimark, B., Ducas, J., Sawatzky, J.V., & Drinkwater, D.T. (1999). Incidence and determinants of injuries sustained by older women during a walking program. *Journal of Aging and Physical Activity,* **7**(1), 91-104.

Ready, A.E., Naimark, B., Ducas, J., Sawatzky, J.V., Boreskie, S.L., Drinkwater, D.T., & Oosterveen, S. (1996). Influence of walking volume on health benefits in women post-menopause. *Medicine and Science in Sports and Exercise,* **28**(9), 1097-1105.

Reaven, P.D., Barrett-Connor, E., & Edelstein, S. (1991). Relation between leisure-time physical activity and blood pressure in older women. *Circulation,* **83**(2), 559-565.

Reeder, B.A., Liu, L., & Horlick, L. (1996). Socioeconomic variation in the prevalence of cardiovascular disease in Saskatchewan: Results from the Saskatchewan Heart Health Survey. *Canadian Journal of Cardiology,* **12**(3), 271-277.

Reid, R.D. (1995). Why don't they stay changed? *Canadian Journal of Cardiology,* **11**(Suppl. A), 26A-29A.

Restrepo, H.E., & Rozental, M. (1994). The social impact of aging populations: Some major issues. *Social Science and Medicine,* **39**(9), 1323-1338.

Russell, S.J., & Craig, C.L. (1996). *Physical activity and lifestyles in Canada* (occasional paper). Ottawa: Canadian Fitness and Lifestyle Research Institute.

Shephard, R.J. (1997). What is the optimal type of physical activity to enhance health? *British Journal of Sports Medicine,* **31**, 277-284.

Siegel, P.Z., Brackbill, R.M., & Heath, G.W. (1995). The epidemiology of walking for exercise: Implications for promoting activity among sedentary groups. *American Journal of Public Health,* **85**(5), 706-710.

Statistics Canada. (1991). *Health status of Canadians: Leisure-time physical activity* (Catalogue No. 11-612E, #8). Ottawa: Statistics Canada.

Statistics Canada. (1995). *National population health survey overview: 1994–95* (Catalogue No. 82-567). Ottawa: Statistics Canada.

Statistics Canada. (1997). *Health statistics at a glance* (Catalogue No. 82F0075XCB). Ottawa: Statistics Canada.

Stephens, T., Jacobs, D.R., & White, C.C. (1985). A descriptive epidemiology of leisure-time physical activity. *Public Health Reports,* **100**(2), 147-157.

Tapp, J.T., & Goldenthal, P. (1982). A factor analytic study of health habits. *Preventive Medicine,* **11**, 724-728.

Taunton, J.E., Martin, A.D., Rhodes, E.C., Wolski, L.A., Donelly, M., & Elliot, J. (1997). Exercise for the older woman: Choosing the right prescription. *British Journal of Sports Medicine,* **31**, 5-10.

Tremblay, A., Despres, J-P., Leblanc, C., Craig, C.L., Ferris, B., Stephens, T., & Bouchard, C. (1990). Effect of intensity of physical activity on body fatness and fat distribution. *American Journal of Clinical Nutrition,* **51**, 153-157.

Unger, J.B., & Johnson, C.A. (1995). Social relationships and physical activity in health club members. *American Journal of Health Promotion,* **9**(5), 3340-3343.

Washburn, R.A., Smith, K.W., Goldfield, S.R., & McKinlay, J.R. (1991). Reliability and physiologic correlates of the Harvard Alumni Activity Survey in a general population. *Journal of Clinical Epidemiology,* **44**, 1319-1326.

Wenger, N.K. (1996). Gender differences in coronary risk and risk factors. In J.E. Manson, P.M. Ridker, J.M. Gaziano, & C.H. Hennekens (Eds.), *Prevention of myocardial infarction* (pp. 387-412). New York: Oxford University Press.

Wister, A.V. (1996). The effects of socioeconomic status on exercise and smoking. *Journal of Aging and Health,* **8**(4), 467-488.

World Health Organization. (1986). *Ottawa charter on health promotion.* Copenhagen: World Health Organization Regional Office for Europe.

Yeager, K.K., Macera, C.A., & Merritt, R.K. (1993). Socioeconomic influences on leisure-time sedentary behaviour among women. *Health Values,* **17**(6), 50-54.