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ENERGY BALANCE OF WOMEN LIVING IN A SENIOR CITIZENS' APARTMENT COMPLEX

by

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A THESIS

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled ENERGY BALANCE OF WOMEN LIVING IN A SENIOR CITIZENS' APARTMENT COMPLEX submitted by GLENDA J. MACWILLIAM in partial fulfilment of the requirements for the degree of MASTER OF SCIENCE in NUTRITION.

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Abstract

During fall, 1978, a study was conducted to assess the feasibility of methods measuring energy intake and expenditure of elderly women during normal daily routine activities. Fifteen female volunteers from Strathcona Place, a high-rise apartment complex designed for senior citizens, in Edmonton, Alberta, participated in the study.

A 7-day weighed food record was used to determine energy intake, while subjects concurrently recorded daily activity changes on a miniature cassette tape recorder. Values from the literature on the energy cost of various tasks were extrapolated to the activity data and used to calculate energy expenditure. Body weight was obtained before and after the 7-day study, to provide a measure of energy balance. In addition, anthropometric measurements were performed to estimate percentage body fat.

Subjects had a mean age of 73 years, body weight of 65 kg and energy intake of 1250 kcal. Comparison with the 55 Alberta women studied in the Nutrition Canada survey showed the two groups to be statistically similar, with respect to age, height, weight, upper arm skinfold thickness, ponderal index and energy intake.

Activities undertaken by the women were categorized according to energy intensity. Subjects spent a mean of 1120 minutes in sedentary pursuits. Light to moderate activities accounted for 230 minutes of the day, while 90 minutes were devoted to more strenuous tasks.

Mean energy expenditure was calculated to be 2150 kcal. The large discrepancy between intake and expenditure was not reflected by the change in body weight over the 7-day period, nor by any recent weight change. The method of calculating energy expenditure may have resulted in an overestimation, as literature values on the energy cost of tasks are principally based on data obtained from younger females. The mean energy intake and expenditure for the first three days was similar to the intake and expenditure calculated over the 7-day period. This was an important finding, since a decrease in motivation and enthusiasm was observed during the latter days of data collection by some individuals.

Results supported the findings of the Nutrition Canada survey, which indicated a high percentage of elderly women to be overweight, despite a minimal energy intake. The majority of women studied felt that a shift in their activity patterns had occurred since moving into Strathcona Place: more strenuous household tasks were replaced by greater participation in recreational activities. For the elderly woman living in a small, self-contained unit within a high-rise complex, energy expended was higher than anticipated and may be due to the method used to collect and calculate the data.

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Table of Contents

List of Tables

List of Tables in Appendix

I. INTRODUCTION

The senior citizen population is increasing more rapidly than any other age group in our society (1). In Alberta alone, the present figure of more than 130,000 residents aged 65 years and over is expected to double by the year 2,000 (2). Since this segment of the population is characterized by a preponderance of women, considerable attention must be focused on the nutritional status of elderly women, if the health of such a large proportion of Canadians is to be promoted (1).

The rare occurrence of undernutrition and gross nutritional deficiencies among Canadians has led much of the population to become complacent about their nutritional status; yet, results of the Nutrition Canada survey (3) identified the need for concern in a number of population groups, one of which was the elderly. Senior adult women were reported to be consuming sub-optimal or marginal intakes of a number of nutrients, including energy, despite the fact that 80% were classified "at risk" on the basis of the ponderal index as an assessment of obesity (3).

In view of the sedentary lifestyle which is practiced by much of the Canadian population, any attempt to maintain ideal weight forces the older individual to consume a diet very low in energy, thus making it extremely difficult to obtain adequate levels of essential nutrients. While lack of physical exercise is common among the elderly, the assumption that it plays the etiological role in the prevalence of obesity among this age group is purely hypothetical.

Senior citizens' housing in large urban centres is being designed in such a way as to minimize energy expenditure: high-rise apartment buildings with elevators, compact living units, easy access to public transportation and close proximity to shopping areas. For the majority of women who have traditionally spent much of their time performing a variety of household tasks, the move to a very small apartment dictates significant alterations in patterns of activity. Suddenly confronted with an environment which places much less physical demand on an individual, the elderly woman must seek alternate activities.

To meet this need, a multitude of recreation centres are being established by governmental and community agencies to provide projects and activities for the elderly. Released from the economic and family responsibilities of previous years, senior citizens are freer to participate in such programs, thus encouraging them to continue their contribution to societal well-being, while extending their years of physical, psychological, and emotional vitality. The atmosphere within an apartment complex for the elderly might promote enhanced participation in such activities, since the individual is surrounded by persons of similar age and interests. Whether the elderly become sufficiently involved, physically, to compensate for the decrease in energy formerly expended in household tasks is a question which remains unanswered. However, if the health and longevity of the elderly are of prime consideration, these data are necessary as a basis for the design of future housing developments for senior citizens in Canada.

The present study was designed to test methods of obtaining data on energy balance in older women and to provide direction for future research. The objectives were as follows:

1. to assess the feasibility of using a 7-day weighed food record to obtain data on the energy intake of elderly women during normal daily living,
2. to assess the feasibility of using a miniature tape recorder and digital watch to obtain data on the energy expenditure of elderly women during normal daily living,
3. to determine energy intake, energy expenditure and anthropometric measurements of women aged 65 years and over living in self-contained units within a selected high-rise apartment complex designed for senior citizens, located in Edmonton, Alberta, and,
4. to compare these data with similar data obtained for Alberta women in the Nutrition Canada survey.

II. REVIEW OF LITERATURE

A. Introduction

The population of Canadian women aged 65 years and over rose from 962,540 in 1971 to 1,126,940 in 1976, or an increase of 14.6% (4). During the same five year period in Alberta, this group expanded even more rapidly, from 59,260 to 72,180, an increase of 17.9% (4). Coupled with this overall growth is a dramatic increase with age in the percentage of women who are single, widowed or divorced (5) (table 1); thus, unmarried women in the older age category constitute a very significant proportion of the population.

TABLE 1: Percentage of Females Single, Widowed or Divorced Over Age 65 as Reported in the 1976 Census of Canada (5)

	TOTAL NUMBER	AGE (yrs) 65-69	70-74	75-79	80-84	85-89	90+
		%	%	%	%	%	%
ALBERTA	72,180	40.56	53.84	68.01	79.89	87.25	92.17
EDMONTON	19,950	44.59	57.14	71.28	82.14	87.78	92.31

In Canada, interest in the nutritional status of elderly women was generated by data from the Nutrition Canada study which found a marginal intake of energy despite a high incidence of obesity. Other Canadian studies reporting energy intake of senior women are limited (3,6,7), while data on energy expenditure during normal daily living are severely lacking. Any attempt to assess the suitability of high-rise apartment living for elderly Canadian women, without information on energy intake and expenditure, becomes extremely difficult.

B. Energy Intake of Elderly Women

Factors Affecting Food Intake of Elderly Women

A host of physical, psychological and social factors may act to hinder optimal food intake in the older individual. Illness and disability are most prevalent among this population group (8). Poverty, lack of education, loneliness, grief, depression and fear of aging also characterize the elderly (9). Certainly, keen appetite and enjoyment of eating are not promoted by such poor psychological states (10).

The elderly may suffer from a variety of major or minor physical afflictions which can affect the nutritional quality of their diets. For example, impairment of taste and chewing functions--decreases in taste acuity, salivary flow, mobility of the mandible, degeneration of tissues in the mouth, dental caries, periodontitis and loss of teeth (11)--may force the older individual to resort to a diet of little more than "tea and toast".

Among healthy women, energy is one of the few nutrients exhibiting a significant decrease in requirement with age

(12); however, modification of food patterns to reduce energy intake is not easily achieved. For many older women, the psychological satisfaction gained from adherence to traditional food habits may outweigh the health benefits attained by altering food patterns and modifying energy intake to accommodate the body's decreased energy need.

Dramatic alterations in lifestyle and geographic mobility in the twentieth century have reduced the concept of the extended family to a historical phenomenon in Canada. Traditionally, younger members of the extended family could be relied upon to satisfy the needs of the elderly for housing, transportation and money; simultaneously, social, health and nutritional needs were met as well (8). Today, social independence and a feeling of isolation, perhaps through loss of a spouse, as well as lack of adequate income are factors which may significantly affect food selection. Attention must be focused upon eradication or improvement of the physical, psychological, and social conditions which militate against the attainment of a well-balanced diet.

__Data on the Energy Intake of Free-Living Individuals__

The Nutrition Canada study obtained energy intake data during 1970-1972 on 860 women aged 65–102 (mean 71±5) years using a 24-hour dietary recall method. The group had a mean body weight of 64±12 kg and a mean energy intake of 1530±622 kcal. Fifty-five of the 860 subjects resided in Alberta. The age of the Alberta women ranged from 65–84 years with a mean of 70±4 years; a mean body weight of 68±14 kg and a mean energy intake of 1421±553 kcal.[1]

Recent studies of the intake of energy among elderly Canadian women have shown similar results. Reid and Miles (6) used a 4-day descriptive record to measure the intake of 39 non-institutionalized women aged 65 years and over in southern Ontario. Mean energy intake was reported to be 1593±447 kcal. A study of the elderly in Vancouver found single women to have a significantly higher energy intake than married women (7). Nutrient intake was assessed by using a 24-hour dietary recall. Energy intake for the 53 single women (mean 74±8 years) was 1449±495 kcal; whereas the 23 married women (mean 69±7 years) consumed only 1108±308 kcal.

A study conducted in the U.S.A. by Grotkowski and Sims (13) used a 3-day descriptive food record to obtain dietary data on a group of free-living senior citizens over the age of 62 years. Mean energy intake for the women studied was 1363±441 kcal. Kohrs et al. (14) examined the nutritional status of elderly residents in Missouri in 1973 and found that energy intake ranged from 633 to 3210 kcal, with a mean of 1619 kcal for 52 free-living female subjects over age 59 years. They used a dietary history method to obtain information about the frequency of food consumed per day, week, month or year.

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[1]Based on raw data on computer tape supplied by Nutrition Canada

In 1958, Durnin and co-workers (15) investigated the food intake of a group of women living alone in Scotland. Seventeen women, with a mean age of 66±3 years, completed a 7-day weighed food record. The energy intake ranged from 1107 to 2283 kcal, with a mean of 1894±299 kcal.

In the several studies conducted to date, the mean energy consumption by women living alone varies from approximately 1350 to 1900 kcal. The intake of just over 1400 kcal consumed by elderly Albertans would be at the lower end of this range.

<u>Data on the Energy Intake of Individuals Residing in Nursing Homes</u>

Individuals residing in nursing homes have a slightly lower energy intake than free-living elderly. This could be a result of poor health, or may be a function of reduced energy expenditure. In 1969, Henricksen and Cate (16) observed 13 women over the age of 65 years who were ambulatory and living in a nursing home in Florida. All foods and beverages delivered to each subject as well as returned portions were weighed. Mean energy intake was calculated to be 1258 kcal with a range of 883-1806 kcal.

In another American study, Justice et al. (17) assessed the diets of 32 women aged 63-93 years also living in a nursing home. For five or six non-successive days, food served to the patients and any food returned were recorded using household measures. Nursing staff noted additional food not eaten by the subjects or any snacks consumed. Mean energy intake was found to be 1388±304 kcal.

Stiedemann and her associates (18) evaluated dietary intake by a weighed record for three consecutive weekdays. They studied 23 women who were ambulatory, but residing in a nursing home in Colorado. Subjects were over the age of 61 years and had a mean body weight of 58±3 kg. The mean energy level was 1333±58 kcal.

Salvosa et al. (19) evaluated the diet of 10 women, with a mean age of 82 years, who resided in a Local Authority Home in England. The mean energy intake for a 7-day period was reported to be 1522 kcal. In this study, the method of dietary evaluation was not specified.

Relationship of Age with Energy Intake

While Justice et al. (17) and Miles and Chapple (20) did not observe a decrease in energy intake with age, Steinkamp et al. (21) reported that food intake was significantly lower after the age of 75 years. The reduction appeared to affect all food groups, with no dramatic decrease in any specific food or food group. In 1962, they used a 1-day descriptive food record to examine the energy intake of 29 women over the age of 65 years in California. Energy intake of 16 subjects aged 65-69 years was 1589 kcal; for 8 women aged 70-74 years, mean intake was 1639 kcal; and for 5 women over the age of 74 years, the intake dropped to 1306 kcal. These findings supported the earlier research by

Bransby and Osborne (22) carried out in England. They used a 7-day weighed food record obtained from 178 women living in their own homes. One hundred and one women aged 62-69 years, 50 women aged 70-74 years and 27 women over the age of 74 years consumed means of 1811, 1700 and 1588 kcal, respectively.

Crooke Fry (23) and co-workers showed that energy intake decreased slightly with age in a group of 32 free-living women with a mean weight of 61 kg. A 7-day descriptive record of food eaten was kept by 26 subjects, while the remaining 6 subjects weighed their food for periods of 25-120 days. No significant differences were noted between the methods. Intake for the 14 subjects aged 65-74 years was 1723 kcal, whereas the mean intake was 1674 kcal for the 18 subjects aged 75-84 years.

Data collected in Scotland by Macleod et al. (24) from 1969-1972 yielded similar results. They studied the energy intake of 187 free-living women over the age of 65 years, using a 7-day history and 24-hour recall which provided a basis for the formulation of a 7-day record. The intake of the 95 women aged 65-74 years was 1786±469 kcal, while that of 92 women over the age of 74 years was slightly lower at 1698±371 kcal. Mean body weights were 64±10 kg and 60±11 kg, respectively. When intake was expressed per kg body weight or per kg lean body mass, the age difference was eliminated.

From their study of elderly women in rural and urban France in 1969, Debry and associates (25) concluded that the marked decline in food intake in urban areas was not observable in rural areas, and that regardless of age, intake was higher in rural than in urban areas. They found that 74 urban subjects, aged 65-73 years, consumed 1809±415 kcal; whereas 58 subjects, over the age of 73 years, consumed 1592±327 kcal. In contrast, 38 rural subjects, aged 65-73 years, consumed 2195±459 kcal and 46 subjects, over the age of 73 years, consumed 2155±504 kcal.

Berry and Dower (26) investigated the energy intake of a group of free-living senior women in Britain and showed that inefficient mastication decreased energy consumption. One hundred and ninety-nine women aged 65-74 years and 160 women greater than age 74 years, with no masticatory difficulties, consumed 1801 and 1672 kcal, respectively. However, 16 subjects aged 65-74 years and 28 subjects over the age of 74 years, with an inability to masticate efficiently, consumed 1585 and 1381 kcal, respectively. Among the women over age 74 years, those with masticatory problems had a significantly lower intake than those with no such difficulties.

Consideration must be given to the many factors which could act to impair attainment of an optimal energy intake.

> "Dietary data can never measure nutritional status as such, but rather can give only indirect or presumptive evidence, which may aid in interpreting more direct nutritional findings on the individuals or groups concerned." (27)

C. Energy Expenditure of Elderly Women

Factors Contributing to the Activity Decline with Age

An age-associated decline in activity levels in the older individual has been related to a variety of physical conditions: accumulation of fat; loss of muscular strength; slowing of reaction time; reduction in motor fitnesses, such as balance, flexibility, agility, power and endurance; reduction in oxygen uptake capacity during hard work; reduction in respiratory reserves; increase in ligamatous injuries and dislocation strains in the shoulders, knees, spine and inguinal region; and increases in blood pressure (28). Shock (29) identified the following changes as occurring from age 30 to 80 years: reduction in resting cardiac output of approximately 30%, a decrease in renal blood flow of approximately 50% and a fall in maximal breathing capacity and maximal oxygen uptake of approximately 60% to 70%. In addition, a drop of 12 kcal per square metre per hour in energy production from age 20 to age 90 years is believed to result from a loss of metabolizing tissues (30).

The proportion of regressive changes attributable to factors accompanying the aging process, per se, is difficult to elucidate, since interaction with environmental influences and pathological conditions confounds the issue. Although chronological age is a poor indicator of physiological function, age differences are more readily observable when an individual undergoes a stressful situation--such as physical exercise--rather than under resting conditions (30).

Astrand (31) found both the aerobic work capacity and the average maximal heart rate during a particular activity decreased with age. A recent study of 95 healthy women aged 19-69 years showed average maximal heart rate to be inversely related to age, although an age-related reduction of treadmill endurance was statistically insignificant (32). Nevertheless, male endurance athletes in their seventies had values of maximal oxygen consumption approximately 30% to 40% greater than those of age-matched normal subjects, indicating the protective effect of continued training in the maintenance of work capacity (33).

Caster (34) indicated that bone density increases with increasing muscle strength and conversely, patterns of inactivity result in decreased muscle mass, as well as demineralization of bone. As Bassey (35) pointed out, physical regression might be retarded by adhering to higher levels of physical activity. Certainly, physical inactivity contributes to obesity, already identified as a major health problem among senior Canadian women. Yet, obesity can also predispose an individual to inactivity. Dorris and Stunkard (36) reported the daily physical activity of a group of obese women to be less than their lean counterparts.

Bassey (35) identified a number of social attitudes which tend to discourage physical activity among the elderly in Britain. Paramount was the fear that exercise will result in injury, illness or tremendous exhaustion. Undoubtedly, similar feelings are prevalent in Canada.

Data on the Energy Expenditure of Elderly Women

While low energy expenditure is frequently deemed responsible for the high proportion of overweight Canadians, few studies have been conducted to determine an individual's energy expenditure throughout normal, daily routines. This dearth of data has been due primarily to the inconvenience of traditional methods for measuring energy expenditure.

Durnin et al. (15) studied 17 women, with a mean age of 66±3 years, in a large town near Glasgow, Scotland. Three of the women studied resided in one-room flats, eleven in two-room flats, and three in three-room flats. While three subjects were crippled with arthritis, the remainder were described as active individuals, with three holding part-time jobs as cleaners.

Energy expenditure was determined from an activity diary kept for one week and checked daily by a researcher. Each individual was calibrated by indirect respirometry, using a Max Planck respirometer, for four activities—walking, sitting, standing, and housework. For other activities carried out during the week, an estimation of expenditure was made for each individual, based on her weight and type of activity. Energy expenditure was calculated by multiplying the energy factor obtained from calibration by the time involved for each activity, and totaling the result for each 24 hour period (table 2). Expenditure records for 7, 6, and 5 days were obtained for 9, 3, and 3 subjects, respectively, and incomplete records for 2 others. For the 15 women studied, the energy expenditure ranged from 1492 to 2409 kcal, with a daily mean of 1987±248 kcal.

Sidney and Shephard (37) were concerned about the inactive lifestyle characterizing much of the Canadian population. They studied the usual activities of a group of senior men and women enrolled in a preretirement exercise program. Prior to beginning a twelve month endurance training period, activity patterns of 21 female subjects, with a mean age of 65±4 years, were assessed from an activity history and a 7-day prospective activity diary. Calculations of energy expenditure were made by the extrapolation of values from the literature on the energy cost of a variety of tasks. The amount of time spent in various activities, as determined from the diary records kept by the 11 women, are shown in table 3. These women were judged to have kept their activity records in the most conscientious fashion. Significantly more time was spent sleeping and eating on the weekend days. Following the training period, each subject completed another prospective diary and wore a heart rate monitor for a 24-hour period. The 1-hour training period, four times per week, increased the energy expenditure of the women by approximately 150-200 kcal per day to 2200 kcal daily.

TABLE 2: Estimation of Time Spent by Elderly Women in Various Activities Throughout a 24-hour Period, as Studied by Durnin et al. (15) (N=15)

ACTIVITY	TIME (min) Mean	Range
Lying in bed	581	494-689
Personal necessities	29	5-47
Standing activities (including housework)	305	134-400
Sitting	436	260-486
Walking	66	19-149
Shopping	23	4-48
TOTAL	1,440	

TABLE 3: Estimation of Time Spent by Elderly Women in Various Activities Throughout a 24-hour Period, as Studied by Sidney and Shephard (37) (N=11)

ACTIVITY	TIME (min) Mon-Fri	Sat/Sun
Sitting	369±40	339±41
Standing	160±37	145±37
Walking	151±24	135±20
Driving	7±7	3±2
Riding (car/bus/subway)	36±14	68±15
Dressing/Bathing	58±7	55±4
Eating	89±13	108±16*
Sleeping	439±11	474±17*
Light physical effort	63±18	72±21
Moderate physical effort	63±18	72±21
Heavy physical effort	11±8	7±4
TOTAL	1,440	1,440
Time spent in walking and light - heavy effort	282±32	248±28

*Significantly different from the weekdays

Salvosa et al. (19) studied the energy expenditure of 32 women, with a mean age of 82 years, residing in Local Authority Homes in the county of Hertfordshire, England; and 20 women, with a mean age of 79 years, living alone in their own homes in North London. Those in the Homes were described as sedentary individuals receiving professional care who seldom left the residence. Their buildings were equipped with elevators and central heating. In contrast, only two of the women living alone were in accommodations with central heating, and all were actively involved in a variety of household tasks. This group was classified further according to living conditions: 12 women lived in dwellings with a separate bedroom--Class A housing; the remaining 8 women lived in accommodations without a separate bedroom--Class B housing. The researchers collected data for both winter and summer from the women living alone. Season of the year was not pertinent for those living in the Homes.

All subjects living alone wore a heart rate monitor for two days and one night to collect expenditure data. The ten most cooperative subjects were calibrated individually, using a Douglas bag technique to determine oxygen consumption. Although these individuals were calibrated while sitting, standing, and performing a low step test, only sitting and stepping values were used to calculate the heart rate-energy expenditure regression line. The average slope of this regression line was used to calculate the energy expenditure for 42 women. A single calibration point was measured for four of these women, while a calculated basal metabolic rate and nighttime pulse rate were used for the remaining subjects.

The mean expenditure for the 32 women in the Homes was 1566 kcal. For the 20 women living alone, the energy expenditure was 1723 kcal in winter and 1698 kcal in summer, although this difference was not significant. Women in Class A dwellings had daily expenditures of 1826 and 1711 kcal for winter and summer, respectively; whereas, those in Class B dwellings expended 1561 and 1677 kcal in winter and summer, respectively. The energy expenditure in winter of women living alone was significantly higher than the expenditure of women residing in the Local Authority Homes.

According to data from these several studies, elderly women expended approximately 1800 kcal per day. Few of the studies have been done in North America but rather in Britain where high-rise apartment complexes with elevators are not common, and shopping for food often takes place on a daily basis. The Canadian lifestyle could dictate a lower daily rate of energy expenditure among elderly women than has been observed in studies conducted to date.

D. Studies of Energy Balance in Elderly Women

Only two research groups have reported data for energy intake and energy expenditure within the same group of subjects. Durnin et al. (15) found the mean expenditure of

1987 kcal per day to be 4.7% greater than the mean intake of 1894 kcal per day in their investigation of free-living elderly women. Salvosa and co-workers (19) examined both intake and expenditure in ten women residing in one of three Local Authority Homes studied, and observed a mean expenditure of 1634 kcal per day, which was 6.9% greater than the mean intake of 1522 kcal per day. Both studies were conducted in Britain.

E. Body Composition of Elderly Women

Significance of Body Fat Determinations

Adequate nutrition throughout life is essential for optimal development of all body compartments. Studies of human body composition have accelerated in the past twenty years, as methods have improved and more researchers appreciate the importance of these determinations. In particular, focus has been centred upon the division of the body into fat and fat-free portions.

Young (38) expressed concern that most studies of longevity associate mortality or morbidity with body weight, rather than with body composition, which may be a more significant factor. Individuals considered to be of "ideal weight" may actually be excessively fat, whereas "overweight" individuals may not necessarily be overly fat or obese. To promote optimal health, obese individuals should be encouraged to lower their percentage of body fat.

Young, therefore, contends that one should be concerned with the relative fatness of an individual rather than just body weight.

Age-Associated Changes in Body Composition

Changes in body composition occur with aging, although the age of onset, as well as the type of change varies among individuals. It is unclear at the present time which changes are inherent in the aging process, per se, and which are attributable to changes in lifestyle.

In a comparison of American and British data, weight generally increased with age; Americans weighed more than their British counterparts; and these differences tended to widen with increasing age (39). Master et al. (40), however, showed a decrease in weight of the American population after the age of 65 years. They attributed this finding to two factors: physiologic loss of tissue due to the aging process and a reduction in the proportion of overweight individuals, resulting from high mortality among such individuals at an earlier age.

Novak (41) describes biologic aging as "a process involving changes that influence the total functioning capacity. These changes affect the chemical morphology of cells and tissues, and concomitant changes occur in physical properties and in the production of metabolic energy". Based on multiple isotope dilution studies, Olesen (42) showed a decrease in body cell mass with age, since the ratios of both intracellular water and total exchangeable potassium to total body water diminish. In a study by Shock et al. (43), of 193 men aged 20 to 95 years, a significant decrease in body size and total body water was found with increasing age. Although the intracellular water declined significantly, the extracellular water was not changed significantly.

These indications of decreased cell mass with age have been supported by research showing a reduction in total body potassium in older individuals (44). Edmonds et al. (45) also observed an age-associated decrease in body potassium concentration in females. They attributed this decline to an increase in total body weight as a result of increased fat accumulation, rather than a fall in total body potassium related to diminished muscle mass as found in older males.

Forbes and Reina (46) reported that both the time of onset and intensity of the decrease in lean body mass with age are delayed in the female, compared to the male. They found lean body mass to remain relatively constant during the child-bearing years, with no dramatic decreases until after the menopause.

Measurements of skeletal weights show a decreasing trend with age, as well (47). Loss of cortical bone thickness is a good indicator of skeletal bone loss. This has been shown to decrease with age in both males and females (48); however, the lifetime loss was three times greater in normal females than males. Similarly, Trotter et al. (49) reported a decrease in bone density with age at a uniform rate within race and sex groups.

Studies of fat tissue have shown even greater changes with age than observed in bone or muscle tissue. Skerlj (50) reported continual increases in internal fat from age 30 onwards, while subcutaneous fat remained unchanged or even decreased in the distal parts of the extremities. Wessel and co-workers (51) observed aging to be characterized by increases in skinfold thickness as well as changes in the pattern of distribution of fat.

Novak (41) reported that fat gradually increased with age. In comparison with women of younger age groups, he found that body fat reached a peak sometime between the ages of 65 and 85 years, whereas the fat-free mass and cellular mass gradually decreased, reaching their lowest values in the oldest age group. While adult women have a higher percentage of body weight as fat than adult men, the difference diminishes in the later decades. During the third to seventh decades, body fatness increases 55% in women compared to an increase of 187% in men over roughly the same time period (38).

Among females, measurements of skinfold thickness provide a better estimate of body fat than other anthropometric measurements (52); however, a reduction in skinfold compressibility has been observed in older individuals (53), which may affect the validity of skinfold measurements in predicting body fat. This decline in compressibility may be explained to some extent by the decrease in skin elasticity with age, and the decrease in the water content of the tissues present in the skinfolds (53).

Effect of Physical Activity on Body Composition

The degree of physical activity undertaken by an individual, at any age, profoundly affects body composition. Trained individuals have a greater proportion of fat-free mass compared with untrained individuals of similar age, height and weight (54). Activities which involve increased muscular work result in a drop in body fat with a concomitant rise in fat-free mass. Conversely, a reduction in muscular activity results in fat accumulation, and as a consequence, fat-free mass falls slightly (54).

Increases in body fat, after discontinuation of intensive muscular activity, have often been attributed to positive energy balance, that is, the individual does not decrease his energy intake in accordance with the fall in energy expenditure. However, Parizkova and Poupa (55) reported contradictory findings. They postulated that fat accumulation might be caused by metabolic changes which resulted from the previous intensive muscular work and then failed to adapt to the decreased level of activity. Fatty acid utilization by muscle is enhanced during exercise; thus, the increased deposition and diminished release of fatty acids from adipose tissue during less stressful activity might persist for a considerable length of time after cessation of intensive activity.

Percentage Body Fat of Elderly Women

While there is a dearth of normative data regarding percentage body fat for individuals of all ages, this is particularly true for the elderly, being a group which has received little attention. The information obtained to date has been gathered by using a variety of different methods. Forbes and Reina (46) conducted longitudinal studies using total body potassium measurements to collect body composition data. They reported a mean of 49% body fat in 144 female subjects aged 65-70 years, who had a mean body weight of 69 kg. Novak (41) also used total body potassium determinations in his study of body composition, and found a mean of 44.76% body fat in 13 women aged 65-85 years. These women had a mean body weight of 63±7 kg.

Somewhat lower values were recorded when total body water determinations were employed to calculate percentage fat. Edelman et al. (56) measured the total body water of five women aged 60-82 years, who weighed 62 kg. Calculation of percentage body fat from these data indicated a mean of 36.5%. A study by Hume and Weyers (57) included four women aged 65-84 years, who weighed 56 kg and had 32% of body weight as fat.

Using a different technique to measure lean body mass, Lesser and Zak (58) calculated the percentage body fat in four females aged 62-68 years, and found a mean of 37.5%. They used the chemical dilution principle, whereby the inert, highly fat-soluble gas, cyclopropane, and the less fat-soluble gas, krypton, were absorbed from a closed respiratory system of known volume.

Young et al. (59) employed the hydrostatic weighing technique to predict body density in a group of older women. The formula of Rathbun and Pace (60) was used to calculate percentage fat. Based on this method, the percentage fat of 14 women with a mean age of 65 years was 44.6%.

Durnin and Womersley (61) used skinfold thickness measurements from four body sites--biceps, triceps, subscapula and supra-iliac--on the right side of the body; and the circumference of the upper arm, upper thigh and calf to calculate linear regression equations for estimating body density. The most appropriate equations were determined from comparison with body density obtained by a hydrostatic weighing technique. They then used the formula of Siri (62) to determine percentage body fat, and found that 37 women, aged 50-68 years, with a mean weight of 69 kg, were calculated to have 39±7.6% fat.

Based on results from a variety of body fat studies of older women, approximately 40% body fat may be an average value for women over age 65 years. However, the choice of technique should be considered when interpreting results.

> "Investigation of individual aspects of changes in body composition during maturation and senescence in periods varying in the intensity of energy intake and output, during phases of adaptation to different

degrees of muscular work, as well as comparison of body composition to various functional indices all point to the dynamic unity of form and function. Body composition is a sensitive reflection of these different influences, and in turn affects bodily function as a whole and with other factors contributes to overall efficiency of body function." (54)

III. EXPERIMENTAL PROCEDURE

A. Selection of Subjects

Description of Housing and Lifestyle

All subjects resided in Strathcona Place, a nine-storey high-rise apartment complex for senior citizens built in 1977 and located in Edmonton, Alberta. It contains 232 units, consisting of a variety of small studio, large studio and one-bedroom apartments, ranging from 389 to 543 square feet in size. Each unit is equipped with full kitchen facilities, and a laundry room is located on the ninth floor. Within the building, a whirlpool, exercise bicycles, pool tables, shuffleboards and a table tennis table are available for use by all tenants. In addition, a city recreation centre for senior citizens is located within a block of the residence.

A number of services are provided for residents. A milk delivery truck stops at Strathcona Place each weekday morning and tenants come down to the front entrance to purchase milk products. Mail is not delivered to each suite; rather, tenants come to a central area in the lobby to receive their mail. Other services, such as nursing and legal consultation, are provided on a regular basis at the recreation centre. Since a multitude of facilities and services are located within a close radius of Strathcona Place, the need for leaving the residence-recreation centre area is minimal. Either at the residence or at the recreation centre, a host of activities such as quilting bees, carpentry work, card games, table tennis games, keep-fit classes and yoga are held on a regular basis. In addition, card parties, dances, and various other social events are held occasionally.

Rent is based on income, with each individual being required to contribute 30% of his/her gross income. Based on the senior citizens' pension and full supplement of $349.50 per month[2], the lowest rental payment would be $104.85 per month, thus leaving approximately $245.00 per month for food and other living expenses.

General Characteristics of Subjects

Potential subjects were contacted by a notice placed in the residence newsletter (appendix, table 1) in October, 1978. Two meetings were held at Strathcona Place to recruit volunteer subjects and to explain, both verbally and by written description (appendix, table 2), the purposes of the research and the responsibilities of the subjects. Twenty-three women volunteered for the study which took place during the months of October through December, 1978. Subjects were chosen according to the following criteria: 65 years of age or older; in reasonable health; ambulatory and able to prepare their own meals. It was necessary that participants be able to see well enough to read a dietetic balance without difficulty. Subjects could either live alone

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[2]Personal communication from Old Age Security, Edmonton

or with husbands.

B. Collection of Data

Food Intake

Several methods can be used to collect data concerning the typical food intake of individuals. These include the dietary diary, 24-hour recall, and weighed food record. The selection of the most appropriate procedure for elderly women is dependent upon the convenience and degree of accuracy desired.

The dietary diary relieves the inconvenience associated with weighing, as subjects are permitted to record food eaten in terms of household measures. It facilitates the recording procedure for individuals incapable of undertaking the weighing method (63), but accuracy is sacrificed for convenience.

The 24-hour recall technique requires the individual to furnish details of all food consumed within the previous 24 hours. Claims of statistical conservatism have been noted regarding energy intake, with over-reporting of small intakes and under-reporting of large intakes (64,65). In addition, Campbell and Dodds (66) reported that an incomplete picture of total intake was elicited from older subjects by the recall method.

The weighed food record is recognized as the most accurate method for collecting data on an individual's typical food intake; however, poor eyesight and other physical problems of the elderly can complicate obtaining reliable data (67). This technique also has been identified as the method carrying the greatest potential of changing the diet of the subjects (64,68). Leitch and Aitken (69), however, contend that food habits are not so easily changed: "Education would be a simpler matter if the occasional presence in the house of an investigator who is not trying to educate were sufficient to induce any significant change, qualitative or quantitative."

Numerous studies have compared the validity of the weighed record with the 24-hour recall method for use with elderly subjects. Gersovitz et al. (64) reported the 24-hour recall and 7-day record to be about equal in accuracy in a group of elderly subjects eating at a congregate site. A study by Macleod (67) of 200 elderly people at home supported this finding: the 24-hour recall correlated well with the 7-day record. Young et al. (70) concluded that for groups of fifty or more, where a ten per cent error would be acceptable, the 24-hour recall would provide a convenient substitute for the 7-day record. For the present study, the degree of accuracy was considered to be of greater priority than convenience, since the balance between energy intake and energy expenditure was to be analyzed; thus, the weighed record was judged to be the most appropriate procedure to use.

Each volunteer was supplied with a 500 g dietetic scale and three plastic containers--a dinner plate, 24 cm in diameter, and two bowls, one 12.5 cm and the other 14.5 cm in diameter. The dishes were light enough to hold a standard serving, yet were within the capacity of the dietetic scale.

Instructions for use of the scale and forms for recording intake (appendix, tables 3,4) were discussed and copies left with each subject. Each participant was requested to maintain her typical food pattern and to record all food eaten for seven days. Small cards were supplied for recording recipes of mixed dishes.

Physical Activity and Energy Expenditure

Choosing a method to measure daily physical activity, and thus energy expenditure, is difficult. Any method chosen should allow an individual to continue with normal daily routine activities, be compatible with the physical abilities of the subjects, and yet be as accurate as possible. Direct and indirect calorimetry, use of a heart-rate monitor, and keeping an activity diary have been used to measure energy expenditure.

The most accurate method is direct calorimetry, where an individual is placed in an enclosed respiration chamber and the liberated heat is measured. However, direct calorimetry is clearly impractical for free-living individuals. Indirect calorimetry is based on the association between energy expenditure and oxygen consumption. The Douglas bag or Kofranyi-Michaelis apparatus, as described by Garrow (63), can be worn by the free-living subject, but the size and weight of the apparatus may physically hinder a subject's participation in many usual activities, thus creating an atypical activity pattern. Also, the instruments are totally unsuitable from the standpoint of social acceptability, as they are cumbersome and readily visible by other individuals.

The use of a heart-rate monitoring device has gained popularity in studies of daily energy expenditure. It is very compact, which is a distinct advantage over respirometry equipment, and allows the individual to function normally. Heart beats are accumulated over a specific time period, then the mean is compared to a regression line to determine the expenditure estimate for a particular activity. To obtain the regression line, subjects are calibrated while performing several activities which vary in energy intensity. Oxygen consumption and heart rate are measured simultaneously. Based on heart rate and oxygen consumption, regression lines are then used to determine energy expenditure.

Heart-rate monitoring has been found to correlate well with oxygen consumption in younger subjects. For example, Bradfield et al. (71) found a regression coefficient between heart-rate and oxygen consumption of greater than +0.95 in 21 of 24 subjects. The technique also enables fluctuations in intensity of activity to be measured, while other methods, such as the activity diary method, utilize only one level of energy intensity throughout an activity period.

Although serious consideration was given to using heart-rate monitoring in the present study, it was not possible, since medical supervision was not available to monitor subjects while undergoing calibration. With the prevalence of heart disease among the elderly, non-medically supervised activity was judged to be risky. The value of heart-rate monitoring in the elderly has not been studied extensively; thus, one might expect arrhythmias and other cardiac malfunctions to reduce the predictive value of the heart-rate monitor in measuring energy expenditure. Payne et al. (72), however, are one group who have studied individuals aged 20 to 80 years and reported that age did not exert a profound influence upon the slope or intercept of regression lines of energy expenditure and pulse rate.

It is questionable whether the heart-rate monitoring method would have been the most appropriate for the subjects in the present study. It would not have been a popular technique. For example, many of the Strathcona Place subjects took advantage of the whirlpool facility in the residence on a daily basis. The use of electrodes with the heart-rate monitor would preclude participation in such an activity. In addition, since subjects must be calibrated while performing activities of varying energy intensity, this technique would have been inconvenient as well as time consuming for subjects, as calibration could not be carried out at Strathcona Place.

Activity diaries have been used widely to measure energy expenditure over 24-hour periods. To determine energy cost, individuals may be calibrated for each activity. A less accurate, but more convenient, alternative is to extrapolate literature values on the energy cost of tasks. Energy expenditure is calculated by multiplying energy cost by the amount of time spent performing the particular task. Due to the variation among individuals, estimates of energy expenditure based on table values may introduce an error of 20% or more (63).

The time which subjects must devote to the recording procedure is an important factor to be considered. If the method is so bothersome as to alter activity patterns, the study of an individual's usual energy expenditure becomes meaningless. In their study of older men and women, Sidney and Shephard (37) found that, in many cases, 7-day written diaries were poorly completed. Curtis and Bradfield (73) observed that their subjects were more careful in recording food intake than recording activities. In addition, those individuals who were the most conscientious in recording activities also kept the most accurate account of intake, since balance between intake and expenditure was closest for those subjects.

In spite of the known limitations of the activity diary method, the method was practical, and thought to create the least physical interference with normal daily routines; thus, the activity diary was chosen for use in the present study. The usual method of collecting data was modified. Subjects were requested to record all activity performed using a tape recorder, rather than writing a description of each activity. Physical activity data were collected for seven days concurrently with the intake data. Each subject was supplied with a miniature cassette tape recorder[3] and digital watch[4]. The cassette recorder measured 7 cm X 14 cm, weighed 281 g, and could be attached at the waist of each subject with a belt. The tape was easily started by pushing a button on the side of the recorder, and stopped by pushing a second button on the top of the recorder. A small red light indicated that the unit was recording. The digital watch had a readily visible face, thus facilitating the time assessment for each activity.

Subjects were asked to record changes in activity requiring longer than one minute to perform. Instructions for operating the tape recorder and recording activities were discussed with each woman (appendix, table 5). Subjects were visited daily, or as required, at which time used tapes were collected and a new tape was supplied. While each woman was encouraged to take the recorder with her and to use it to record all activities, small cards were provided for keeping a written record when subjects found it inconvenient to use the tape recorder. Shortly after completion, research staff transcribed the activity records from the tapes and any unclear descriptions were checked with the subjects for

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[3]Lloyd's Electronic Secretary Model V916
[4]Timex Marathon Solid State LCD

clarification.

Body Composition

Numerous methods have been developed for the measurement of body composition, each with advantages and disadvantages regarding convenience and precision. Of all techniques available at present, Womersley et al. (74) contend that measurements of total body water, total body potassium or body density by hydrostatic weighing provide the most reliable estimates of body fat. Garrow (75) does not agree, and maintains that the best estimation of body composition, in vivo, should encompass the determination of fat by gas dilution, as well as body water and potassium measurements. While all these techniques provide a high degree of accuracy, convenience is minimal. Anthropometric methods greatly enhance the ease of estimating body fat, and this constituted an important consideration in measurements of the elderly women in this study. Heavy demands were placed upon the subjects regarding collection of intake and expenditure data. Selection of a convenient technique for measuring body composition had high priority; thus, several methods of estimating body composition were used.

A beam balance with a height measure was used to collect height and weight data. Body height and weight were obtained on Day 1 of the study and again on Day 8. Subjects were weighed and measured wearing a disposable cape and nylon slip.

Skinfold measurements were performed on Day 8 at two body sites: upper arm and abdomen. A Lange skinfold caliper, exerting a pressure of 10 g/mm² of jaw surface, was used for all skinfold measurements throughout the study. The methods employed when making skinfold measurements vary markedly. The trend in Britain is towards taking measurements on the left side of the body, while the right side is used more frequently in the U.S.A. (76). In the present study, the upper arm skinfold measurement was performed on the left arm, similar to that done in the Nutrition Canada survey. For the abdominal skinfold measurement, the right side was used, as suggested by Young (77).

Skinfolds lifted with two hands by an assistant result in lower readings than when performed using the one-handed pinch technique (76). In this study, the two-handed technique was used. One person grasped a double thickness of skin and underlying adipose tissue with two hands while the other person took the reading with the caliper. For all skinfold measurements, two readings were performed. Behnke and Wilmore (78) suggest that a third reading is necessary, if a discrepancy of greater than one per cent exists between the first two readings. Use of the Lange calipers in this study prevented such accurate measurement; however, if readings differed by more than 0.5 mm, a third reading was taken. The two individuals who performed all measurements had taken approximately 100 skinfold thickness measurements prior to the study.

To measure the skinfold of the upper arm, the left arm was flexed such that the ulna and humerus formed a right angle. Using a flexible measuring tape, the midpoint between the acromion and olecranon processes was determined. The arm was then extended, and with muscles relaxed, the skinfold was measured at the midpoint. The abdominal skinfold reading was made 5 cm to the right of centre and at the level of the umbilicus. A fold of skin and fat was grasped parallel to the long axis of the body, with the subject's abdominal muscles relaxed.

A broad blade anthropometer, calibrated in millimetres, was specially constructed and used for the determination of the bideltoid diameter. The technique employed by Young (77) was used. Subjects stood erect with feet together and arms hanging at the sides; heels, buttocks and shoulders were flat against the wall. The diameter was measured at the point of maximal protrusion of the deltoid muscles. Using a flexible measuring tape, abdominal circumference was obtained at the level of the umbilicus, with subjects standing erect, feet together and the abdominal muscles relaxed (77).

Questionnaire

An interview questionnaire was administered to each subject by a member of the research staff, to obtain subjective data regarding the individual's socio-economic status, food practices, medical condition, drug usage and activity patterns (appendix, table 6). Questions 1-12, 17-19, 21 and 26 were patterned from the Nutrition Canada survey (3) to facilitate future comparative study with the Nutrition Canada data. Items 13-16 were included to obtain an indication of usual eating habits, and thus a measure of the typicalness of the food intake data throughout the 7-day period. Question 20 solicited pertinent medical information which might affect diet and activity. A history of the subject's changes in body weight was provided by questions 23-25, while items 27-30 supplied data on the usual activities undertaken by the subject. Questions 22 and 31-33 focused on attitudes concerning the individual's present lifestyle.

C. Experimental Outline

Subjects were required to participate for nine successive days (Day 0 to Day 8):

Day 0: Each volunteer was visited in her apartment suite and the purposes of the research were described. Methods to be used for collecting data were explained and demonstrated, and forms for recording data were distributed. Written informed consent was obtained from each subject (appendix, table 7). For the remainder of Day 0, each participant was encouraged to practice the procedures to be followed during the study.

Day 1: Each subject began to collect data and was visited during the morning by the research staff to measure body height and weight, to check the initial data collected, and to clarify any problems. The interview questionnaire also was administered.

Days 2-7: Subjects were visited daily, or as required, to collect both food intake and energy expenditure data, to check the accuracy of the data collected, to reinforce the use of proper data collection procedures, to provide advice on any specific problems encountered, and to foster rapport to ensure continued cooperation. Frequent visits also afforded an opportunity for researchers to obtain subjective data concerning the practicality of the procedures being used to collect data, and attitudes of subjects toward lifestyle and accommodation at Strathcona Place.

Day 8: Body weight was obtained at, or as closely as possible to, the same hour as on Day 1. Upper arm skinfold, abdominal skinfold, abdominal circumference and bideltoid diameter measurements were performed.

D. Treatment of Data

Intake data were coded according to Composition of Foods, Handbook #8 (79). Supplemental codes provided by Nutrition Canada and another researcher (80) were used to calculate the nutrient composition of specific Canadian products. Estimates, by subjects, of food eaten away from home were converted to their weight equivalents (81). For composite dishes not included in Handbook #8, a standard cookbook recipe was consulted to obtain ingredient information. Data were keypunched and calculation of nutrient composition performed by use of computer tape.

Daily activity records were transcribed from the miniature cassettes to energy expenditure data sheets (appendix, table 8). Literature values on the energy cost of various activities were used to determine total energy expenditure (82-84) (appendix, tables 9,10). Calculations were made on the basis of the subject's initial body weight. An estimate of basal metabolism--used for sleeping metabolism--was calculated from height, initial body weight and age, using the formula developed by Kleiber (85) (appendix, table 11). Maintenance energy need was established as four-thirds basal estimate (86). Expenditure of energy was divided into five categories on the basis of energy cost, category 1 requiring the least expenditure and category 5 requiring the most (appendix, table 12). These categories were similar to the descriptive categories used by Durnin et al. (15) and Sidney and Shephard (37) (tables 2,3).

Measurements of body height and weight obtained on Day 1 were used to compute ponderal index[5] (appendix, table 13). An estimate of specific gravity was determined using the regression equation developed by Young (77) which employs the abdominal skinfold, abdominal circumference and

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[5]Inverse ponderal index

tideltoid diameter (appendix, table 13). The estimate of specific gravity was then converted to percentage body fat, as calculated by the equation of Rathbun and Pace (60) (appendix, table 13). Fat-free mass was determined by subtracting the weight of the body fat from the Day 8 body weight. Change in actual body weight over the seven days was determined. In addition, predicted energy balance was calculated from total intake and expenditure data.

Results over the seven days for energy intake, energy expenditure and nine major nutrients--protein, calcium, phosphorus, iron, vitamin A, thiamine, riboflavin, niacin and vitamin C--were compared with the Canadian Dietary Standard (12) for women over the age of 65 years (appendix, table 14). A summary of these results with suggestions for improved dietary practices, a copy of Canada's Food Guide (87) and a booklet on meal planning for senior citizens (88) were sent to each participant.

E. Statistical Analysis

All statistical analyses were performed by computer program. The mean, range and standard deviation were calculated for the following variables: age, body weight (Days 1 and 8), body height, upper arm skinfold thickness, ponderal index, percentage body fat, fat-free mass, 7-day energy intake, energy intake/kg Day 1 body weight, energy intake/kg fat-free mass, 3-day energy intake, 7-day energy expenditure, calculated basal metabolism, calculated maintenance energy requirement and the distribution of time among the five categories of activities.

One-way analysis of variance was carried out to determine any significant difference between the 7-day and 3-day intake data. In addition, data from the present study were compared with data from Alberta women studied in the Nutrition Canada survey using one-way analysis of variance.

Pearson correlation coefficients were computed to determine the relationship of age with a number of energy variables: intake, intake/kg Day 1 body weight, intake/kg fat-free mass, and expenditure. Pearson correlation coefficients were also determined for several anthropometric variables: percentage body fat with upper arm skinfold thickness, ponderal index, and body weight; upper arm skinfold thickness with ponderal index and body weight.

IV. RESULTS AND DISCUSSION

A. Subjects

Twenty-three women volunteered for the study as a result of the two initial meetings at Strathcona Place. After further thought, several women decided not to participate, leaving nineteen subjects who began data collection. Of these nineteen women, three became ill during the collection period and were forced to withdraw. One additional subject became ill on Day 0 and did not record food intake or activities during Day 1. While she continued to participate, her data were incomplete and judged to be unreliable by the research staff; thus, data are presented for fifteen subjects. This number fell short of the original objective of twenty subjects.

Subjects ranged in age from 65 to 84 years, with a mean of 73 years. Height measurements performed on Day 1 ranged from 139.0 to 167.0 cm with a mean of 155.7 cm. Mean body weight, as measured on Day 1, was 64.6 kg, with a range of 47.9 to 86.7 kg. On Day 8, mean body weight was 64.8 kg, ranging from 48.1 kg to 87.0 kg, a net gain of 0.2 kg over the 7-day period. Table 4 shows individual data for age, height and body weight.

All fifteen volunteers appeared to be in reasonable health; however, three subjects were diabetic: subjects 04 and 09 controlled by diet alone, and subject 14 dependent upon insulin. Subjects 04 and 10 took diuretic drugs. While

TABLE 4: Age, Height, and Body Weight (Days 1 and 8) of Strathcona Place Women

SUBJECTS	AGE	HEIGHT	BODY WEIGHT DAY 1	BODY WEIGHT DAY 8
	yrs	cm	kg	kg
01	66	167.0	61.3	62.7
02	74	157.5	63.4	64.7
03	67	159.8	66.2	65.7
04	69	152.0	78.0	78.2
05	74	152.0	77.4	78.1
06	69	160.8	86.7	87.0
07	84	150.0	53.0	52.1
08	68	153.0	54.2	54.1
09	82	158.5	52.9	52.2
10	74	165.5	74.0	75.9
11	77	155.3	47.9	48.1
12	73	163.0	62.4	62.2
13	67	152.3	71.3	71.1
14	65	150.5	64.5	63.9
15	80	139.0	56.3	56.5
MEAN	73	155.7	64.6	64.8
SD	±6	±7.2	±11.1	±11.4

only two subjects did not wear dentures, there was no severe impairment of biting or chewing ability among the edentulous women. Only a few items, such as raw apples and tough meat, provided any masticatory problems.

Two women lived with their husbands; the remaining subjects lived alone. Detailed information on income and living expenses was not ascertained. A number of subjects interviewed initially were reluctant to answer question #8 from the questionnaire regarding income (appendix, table 6); therefore, the question was deleted and not asked of the remainder of the subjects.

Selection of subjects is perhaps the most contentious issue in dietary surveys of the elderly. Owing to the time involved in maintaining a weighed food record, random sampling from a population is rarely feasible, as subjects are usually volunteers interested in participating. There is an increased likelihood the group studied may consist of a high proportion of health-motivated individuals (89). This may have been true of the participants in the present study, since results from the questionnaire indicated that subjects felt they were active individuals for their age. In addition, only one individual in the group believed she was not consuming a well-balanced diet. Subjects in this study, then, cannot be expected to be representative of a population, but as Dibble et al. (89) noted, "few investigators studying healthy, independently-living groups in a community have overcome this problem."

B. Food Intake

Intake of Energy

Mean daily intake over the 7-day period was 1246 kcal, and ranged from 878 to 1677 kcal (table 5). When expressed on the basis of Day 1 body weight, daily intake ranged from 11.3 to 23.9 kcal/kg, with a mean of 19.5 kcal/kg (table 5). In terms of estimated fat-free mass, mean daily intake was 30.6 kcal/kg, ranging from 17.7 to 37.8 kcal/kg (table 5). Subject 06, who had the greatest energy intake--1677 kcal--was also the heaviest subject--86.7 kg; however, her consumption, when expressed as 19.3 kcal/kg Day 1 body weight and 33.0 kcal/kg fat-free mass, was very close to the group means.

The mean daily intake for Days 1 to 3 was calculated and found to be 1209 kcal. This was compared with the 7-day mean of 1246 kcal (table 5). These levels were similar, as results of analysis of variance yielded no significant difference between the means for the 7-day data and the 3-day data ($P>0.05$).

Intake of Other Nutrients

As might be expected, in view of the low energy consumption, adequate levels of all essential nutrients were not achieved. Mean calcium intake was less than 600 mg/day, compared with the Canadian Dietary Standard (12) recommendation of 700 mg/day for women aged 65 and over. Thiamine intake also was sub-optimal. Seven women took

TABLE 5: 7-day Energy Intake: Intake, Intake per kg Body Weight and per kg Fat-free Mass; and 3-day Intake of Strathcona Place Women

SUBJECTS	INTAKE			
	7-DAY	/KG BODY WEIGHT	/KG FAT-FREE MASS	3-DAY
	kcal	kcal	kcal	kcal
01	1269±348*	20.7	19.2	1037
02	1155±370	18.2	26.9	1038
03	1444±520	21.8	34.1	1578
04	878±246	11.3	17.7	1113
05	1263±383	16.3	24.4	1326
06	1677±228	19.3	33.0	1699
07	1055±218	19.9	29.5	1036
08	1160±185	21.4	32.9	1112
09	1058±257	20.0	33.6	972
10	1562±327	21.1	34.0	1531
11	1146±260	23.9	36.0	1054
12	1196±348	19.2	28.6	903
13	1353±282	19.0	29.2	1220
14	1253±087	19.4	31.5	1242
15	1221±159	21.7	37.8	1281
MEAN	1246	19.5	30.6	1209
SD	±202	±2.9	±5.0	±236

*Mean±SD

vitamin supplements on a regular basis: two subjects took a vitamin E preparation, two subjects took a B-complex tablet with added vitamin C and three subjects were using a multi-vitamin preparation. Yet, all subjects, except subject 07, believed they were consuming nutritionally well-balanced diets.

The use of vitamin preparations was not judicious. In a number of cases, supplements were taken by subjects already receiving generous intakes of vitamins from food, and not by those women with the poorest diets. For example, one subject took a vitamin C tablet and a multi-vitamin preparation containing vitamin C, while the vitamin C furnished by her daily diet was already in excess of the recommended intake. Minkler (90), in her study of the urban elderly, found that the majority of respondents believed they had a greater need for vitamin supplements than younger people, even if they were consuming nutritious diets. This might help to explain the non-discriminative use of vitamin preparations by Strathcona Place women.

Comparison of Intake Data with Results Found by Others

The results of analysis of variance comparing the mean 7-day energy intake from the present study--1246 kcal--with that for Alberta women studied in the Nutrition Canada survey--1421 kcal--showed no significant difference between the two groups ($P>0.05$) (table 6); thus, the intakes of the two groups were similar. In Britain, Durnin et al. (15)

TABLE 6: Comparison of Anthropometric Measurements and Energy Intake of Strathcona Place Women (N=15) and Alberta Women Studied by Nutrition Canada (N=55)

	STRATHCONA PLACE	ALBERTA	F RATIO	F PROBABILITY
AGE (yrs)	73±6*	70±4	4.109	0.0466
	(65-84)**	(65-84)		
WEIGHT (kg)	64.6±11.1	67.9±13.8	0.714	0.4011
	(47.9-86.7)	(43.9-101.8)		
HEIGHT (cm)	155.7±7.2	155.3±6.8	0.052	0.8199
	(139.0-167.0)	(139.4-171.8)		
UPPER ARM	25.9±8.1	22.6±6.4	2.924	0.0918
SKINFOLD (mm)	(9.5-39.5)	(7.0-38.0)		
PONDERAL	11.8±0.8	11.6±1.0	0.561	0.4564
INDEX	(10.8-13.2)	(9.1-13.4)		
ENERGY	1246±202	1421±553	1.437	0.2347
INTAKE (kcal)	(878-1677)	(626-3018)		

*Mean±SD
**Range

obtained a mean of 1894 kcal for energy intake using a 7-day weighing technique; however, their subjects had a mean age of 66 years, which was less than the mean age of 73 years for subjects in the present study. Reid and Miles (6) found a mean intake of 1593 kcal for subjects aged 65 and over in Ontario. Leichter et al. (7), in Vancouver, reported intakes of 1449 and 1108 kcal, for single women with a mean age of 74 years, and married women, with a mean age of 69 years, respectively. Data from ambulatory women over age 61 years residing in U.S. nursing homes were very similar--1258-1388 kcal (16-18).

Relationship of Age with Energy Intake

Table 7 reports the Pearson correlation coefficients for age with three energy intake variables. In the present study, as age increased, energy intake decreased, although the correlation was not significant. This negative correlation between age and energy intake supports the findings of several other researchers (21-25). Macleod et al. (24) noted that the negative correlation between age and energy intake was eliminated when intake was expressed in terms of body weight or fat-free mass. This also occurred in the present study; hence, it would appear that age, per se, does not dictate a decrease in energy intake.

Evaluation of the 7-day Weighed Record Method

Several subjects expressed some initial difficulty in

TABLE 7: Pearson Correlation Coefficients for Age with Energy for Strathcona Place Women (N=15)

	AGE
ENERGY INTAKE	-0.3508 (0.100) *
ENERGY INTAKE/KG BODY WEIGHT	+0.1842 (0.256)
ENERGY INTAKE/KG FAT-FREE MASS	+0.2372 (0.197)
ENERGY EXPENDITURE	-0.5573 (0.015)

*Level of probability

interpreting the scale on the dietetic balance; however, familiarity with the technique over the seven days facilitated the recording procedure. Accuracy obtained was felt to be very high, although it was achieved at the expense of convenience. Subjects found the weighing of individual items, such as separate weighings of butter, jam and bread for a slice of toast, to be a tedious chore. Several women complained that hot foods became cold before they had completed weighing all meal items, even though the plastic containers provided enabled participants to weigh a number of foods on the same dish at one time. As the week progressed, however, familiarity with the technique facilitated more rapid measurement. The speed of data recording also was increased by using pre-typed sheets (appendix, table 4).

Subjects were given small cards on which to record a description of the food and an estimation of the amount eaten when they ate away from their apartment suites. Curtis and Bradfield (73) had previously used this method with success. This procedure encouraged subjects to follow their usual eating pattern, and helped to ensure a complete record of food consumption. Some difficulty was experienced by research staff in converting subject descriptions of intake to weight equivalents for calculation purposes. Amounts found in standard recipes in household cookbooks assisted in the conversion.

Frequent visits by staff, to ensure accuracy of data collection and continued enthusiasm of volunteers, have been deemed necessary by others to the success of the weighed food method (67,73,91,92). In the present study, daily visits did not always seem necessary, although most subjects were visited on a daily basis. After one subject became familiar with the procedures during the initial days, she suggested that the research staff not return until Day 8. She was visited only twice during the 7-day period, yet her data proved to be the most complete and were judged to be the most reliable of all subjects, since all food items consumed over the seven days had been weighed. For the majority of subjects, frequent visits not only reinforced and instilled confidence in the subjects, but also provided an opportunity for researchers to develop rapport with the subjects. This was particularly beneficial in collecting subjective data.

Durnin and Brockway (93) maintain that seven days is the minimal amount of time required for observation of energy balance. Nevertheless, it was felt by research staff that interest did decline towards the end of the 7-day period. This observation also has been reported by Gersovitz and co-workers (64). The mean daily intake for seven days was 1246 kcal, compared with the mean intake of 1209 kcal for the first three days (table 5). This was a difference of only 3%. Subjects indicated a change in the times of food consumption on weekends; hence, selection of consecutive weekdays would seem appropriate if a 3-day record was to be used. The large standard deviation noted within the subjects' 7-day data (table 5) would suggest that selection of a 1-day record would not be appropriate for this group of elderly women.

C. Physical Activity

Energy Expenditure Data and Comparison with Results Found by Others

Mean daily energy expenditure over the seven days was 2153 kcal, with a range of 1677 to 2843 kcal (table 8). Calculated on the basis of Day 1 body weight, daily expenditure ranged from 31.3 to 36.6 kcal/kg, with a mean of 33.4 kcal/kg (table 8). When expressed in terms of estimated fat-free mass, mean daily expenditure was 52.1 kcal/kg, ranging from 46.9 to 58.7 kcal/kg (table 8). Energy expenditure was approximately 1000 kcal greater than the basal metabolism of 1169 kcal calculated using the Kleiber formula (85). Expenditure exceeded the calculated maintenance requirement of 1558 kcal by approximately 600 kcal (table 8).

The mean of 2153 kcal obtained for energy expenditure by Strathcona Place subjects does not vary greatly from that observed elsewhere. In Britain, Durnin et al. (15) reported a mean of 1987 kcal, in a free-living group of elderly women, while Sidney and Shephard (37) found that expenditure ranged from 2000-2050 kcal in a group of elderly Canadian

TABLE 8: 7-day Energy Expenditure: Expenditure, Expenditure per kg Body Weight and per kg Fat-free Mass; Estimated Basal Metabolism and Estimated Maintenance Requirement of Strathcona Place Women

SUBJECTS	EXPENDITURE 7-DAY	/KG BODY WEIGHT	/KG FAT-FREE MASS	CALCULATED BASAL METABOLISM	ESTIMATED MAINTENANCE METABOLISM
	kcal	kcal	kcal	kcal	kcal
01	2229	36.4	51.3	1256	1674
02	2206	34.8	51.5	1164	1551
03	2148	32.4	50.7	1245	1659
04	2481	31.8	50.1	1271	1695
05	2654	34.3	51.3	1227	1636
06	2843	32.8	56.0	1402	1869
07	1677	31.6	46.9	975	1300
08	1847	34.1	52.3	1088	1451
09	1720	32.5	54.6	1038	1384
10	2315	31.3	50.4	1304	1739
11	1755	36.6	54.1	999	1332
12	2033	32.6	48.6	1198	1598
13	2261	31.7	48.8	1234	1645
14	2224	34.5	55.9	1178	1571
15	1895	33.7	58.7	952	1269
MEAN	2153	33.4	52.1	1169	1558
SD	±342	±1.7	±3.2	±132	±175

women, who were entering a pre-retirement exercise program. The expenditure of elderly women living in nursing homes was considerably lower, 1566 kcal, while senior women living alone expended 1723 kcal in winter (19). The latter study also was conducted in Britain.

Table 7 reports the Pearson correlation coefficient for age with energy expenditure. The negative coefficient, -0.5573 ($P<0.05$), indicates a decrease in energy expenditure with age.

<u>Basal Metabolism and Energy Used for Maintenance</u>

The mean basal metabolism, calculated using the method of Kleiber (85), was 1169 kcal (table 8)--only 77 kcal less than the mean energy intake. Basal metabolism was used to estimate energy expended during sleeping. Buskirk (94) notes that energy expended during sleep varies with the depth of sleep, sleeping environment, body movements while sleeping, both quantity and type of food eaten prior to sleeping, and the intensity of physical activity undertaken during the day. Durnin and Passmore (82), however, contend that the energy expended throughout the entire sleeping period can be reflected accurately by the measurement of basal metabolism.

Since basal metabolism was used to estimate sleeping expenditure, further investigation of the validity of this method was deemed necessary. To check the validity, the basal metabolic rate was measured in three subjects who participated in the study. The three women whose intake data were deemed most reliable were brought to the laboratory for a measurement of basal metabolism. Instructions were given to the women to be in the fasting state and to undertake no strenuous activity before leaving the residence at 8:30 A.M. Before beginning to measure the basal metabolism, subjects were placed in the prone position and were encouraged to relax for approximately ten to fifteen minutes. A mouthpiece was then inserted and the nose clamped. Respired gases were collected and the basal metabolic rate measured using a Beckman Metabolic Measurement Cart[6]. Approximately twenty to thirty minutes were required to achieve values reflecting a steady state. Resting basal energy expenditure was calculated from the respiratory quotient, using the Lusk values reported by Mathews and Fox (95).

Calculations for subject 03 indicated an actual basal metabolism of 970 kcal/day versus a calculated basal metabolism of 1245 kcal/day using the Kleiber formula (85). For subject 06, actual measurement was 1704 kcal/day and the calculated basal was 1402 kcal/day. Subject 08, who later revealed she had not been in the fasting state, had an actual value of 1190 kcal/day, which more closely approximated the calculated value of 1088 kcal/day. Because of the lack of agreement between calculated and actual values, no conclusion as to the validity of the calculated figures can be drawn. The means of the calculated and actual values for these three subjects can be misleading, for they

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[6]Beckman Instruments, Illinois

were similar--1245 and 1288 kcal, respectively.

The energy cost of various activities reported by Passmore and Durnin (82-84) are expressed as basal metabolism, plus the energy cost of the specific task. Literature figures are available on the energy cost of tasks excluding the basal metabolism (96), and calculations using this method were carried out for several women in the present study. Comparison of these results with the results using the values reported by Passmore and Durnin (82-84) showed no significant difference ($P>0.05$); therefore, Passmore and Durnin's tables were used throughout this study because they cite a much wider variety of tasks undertaken by housewives than the available figures which exclude the basal factor.

The Kleiber formula for calculating basal metabolism (85) is based upon body weight, with correction factors for actual age and actual stature (appendix, table 11), thus accounting for the effect of age on basal metabolism. The maintenance energy requirement was calculated as four-thirds the basal value (appendix, table 11), and again, the effect of age is considered. The mean estimated basal requirement was 1558 kcal, approximately 400 kcal greater than the basal value of 1169 kcal (table 8).

Activity Patterns

Table 9 summarizes the distribution of time among the five activity categories. Activities in categories 1 and 2 could be described as sedentary, and included such items as sleeping, sitting, watching television, knitting, eating and playing cards. Subjects spent a mean of 1120 minutes, or the greatest portion of their time, in activities classified as 1 and 2. Light to moderate activities, such as personal necessities, typing, meal preparation, sweeping the floor and washing small clothes by hand (categories 3 and 4), accounted for 233 minutes of the day. A mean of 87 minutes were devoted to walking and other more strenuous activities (category 5). Individual data are shown in table 10.

The apportionment of time (table 9) was comparable to that noted by Durnin and associates (15) and Sidney and Shephard (37) (tables 2,3). In particular, the 288 minutes involved in the most energy-intensive categories, 4 and 5, were very similar to the 282 minutes devoted to active weekday pursuits observed by Sidney and Shephard (37).

Comparison of the usual expenditure patterns, provided by questionnaire, with the 7-day expenditure data did not indicate any major dissimilarities. Six women reported that their activities were restricted by a chronic physicial condition: two with arthritis, two with heart problems, and two with hip abnormalities; yet, most of the fifteen subjects indicated that they were active individuals for their age. While four women admitted to being more active since moving into Strathcona Place, the majority of subjects did not indicate an increased level of activity; however, they noted a reduction in housework and strenuous activities

TABLE 9: Summary of Activity Distribution by Strathcona Place Women (N=15)

ACTIVITY LEVEL kcal/kg/min	DESCRIPTION OF EXAMPLES	TIME min
1. <0.019	sleeping, lying down	539±49*
2. 0.019-0.029	sitting - eating, sewing, T.V., standing quietly	581±45
3. 0.030-0.039	typing, sweeping floor, stirring, personal necessities >10 min	32±32
4. 0.040-0.049	meal preparation, hand-washing, personal necessities ≤10 min	201±45
5. ≥0.050	walking, kneading dough, mopping stair-climbing, bed-stripping	87±24
TOTAL		1,440

*Mean±SD

TABLE 10: Distribution of Time Among 5 Activity Levels by Strathcona Place Women

SUBJECTS	CATEGORY 1	2	3	4	5
	min	min	min	min	min
01	453	601	18	265	103
02	546	536	10	211	136
03	617	543	15	165	100
04	570	552	47	212	58
05	503	572	4	245	116
06	535	591	25	210	80
07	581	596	17	179	67
08	596	501	81	205	56
09	578	585	11	206	60
10	589	590	0	182	79
11	478	574	48	257	83
12	501	690	65	101	84
13	544	632	2	141	121
14	510	545	111	182	93
15	488	606	27	254	66
MEAN	539	581	32	201	87
SD	±49	±44	±32	±45	±24

concomitant with an increased participation in recreational activities. The programs at the adjacent city recreation centre attracted many of the individuals in the residence. In addition, the eating facility at the centre employed the volunteer services of a number of the subjects for at least one morning per week.

Nearest access to the public transportation system was approximately one block from the residence. While a small grocery store was available one block from Strathcona Place, the closest major grocery outlet was about seven blocks away. However, many subjects reported that they took the bus to the downtown area for grocery shopping, since a supermarket there provided free delivery service. Complementary city bus passes enabled tenants to use the public transportation free of charge at non-peak hours.

Subjects indicated that they usually did much less walking in winter than in summer. The study was conducted during the autumn season and there was a considerable difference between the weather at the outset and that at the end of the study--the warm days of October giving way to a number of rather wintry days in December. Yet, there were no icy conditions which would have prevented subjects from freely moving about and walking outside; thus, activity of subjects should not have been curtailed by any environmental factors which differed from the beginning to the end of the study.

During winter, some subjects attempted to compensate for restricted outdoor activity by increased activity within the building. Several women noted that the U-shaped design of the building afforded an opportunity for more walking than if the residence had been constructed in the more usual rectangular fashion. Several subjects reported that they exercised by climbing one flight of stairs, walking the full length of the building, climbing another flight, again walking the length of the corridor, and so on, until they reached the top. However, while stairwells were large and steps very shallow in depth, there was no access by stairs from the second floor to the lobby on the first floor; thus, even those individuals wishing to use the stairs were forced to use the elevator to move from the first to the second floor.

Evaluation of the Activity Diary Method

The use of a miniature tape recorder for recording activities in the present study is an innovative procedure. The technique appeared to be easy and convenient, and was thought to provide a more accurate account of activity compared with the written record; however, subjects did not completely agree with this evaluation. Many subjects were not familiar with the equipment and initially felt uncomfortable regarding its use. Subjects who used the equipment had no difficulty in operating the recorder, and several subjects were most enthusiastic. Only two women were reluctant to use it and requested that they be allowed to write their activities instead. Another woman wrote all activities as they occurred, then made one tape entry for the entire day.

The digital watch allowed the subjects to record the time easily, since precise time was visible at just a glance at the watch, thus achieving greater accuracy than with a conventional watch. While the precision of the time record was generally good for activities performed within their suites, subjects tended to be more casual regarding the measurement of time away from their suites; thus, likely introducing a larger error when subjects were away from the residence. Although subjects were encouraged to be more specific about recording time, there is a limit to the demands which researchers can place upon volunteer individuals.

D. Body Composition

Anthropometric Measurements

Ponderal index, calculated as height in inches divided by the cube root of the Day 1 body weight in pounds, ranged from 10.8 to 13.2 with a mean of 11.8 (table 11). Nutrition Canada (3) identified individuals with a ponderal index of 11.6 to 12.5 to be at moderate risk, and those with a ponderal index of <11.6 to be at high risk; thus, subjects in this study were at moderate risk with respect to obesity. Values for the left upper arm skinfold thickness ranged from

TABLE 11: Ponderal Index, Upper Arm Skinfold Thickness, Percentage Body Fat, and Fat-free Mass of Strathcona Place Women

SUBJECTS	PONDERAL INDEX	UPPER ARM SKINFOLD	BODY FAT	FAT-FREE BODY MASS
		mm	%	kg
01	12.8	21.5	30.7	43.5
02	12.0	24.7	33.7	42.9
03	12.0	30.8	35.6	42.3
04	10.8	39.5	36.6	50.0
05	10.8	38.7	33.8	51.7
06	11.0	26.7	41.7	50.8
07	12.1	22.0	31.3	35.8
08	12.2	21.0	34.7	35.3
09	12.8	18.0	39.5	31.5
10	11.9	25.0	39.5	45.9
11	13.2	9.0	33.8	31.8
12	12.4	20.0	32.7	41.8
13	11.1	33.3	34.8	46.4
14	11.4	26.0	37.8	39.8
15	11.0	33.3	42.8	32.3
MEAN	11.8	25.9	35.9	41.5
SD	±0.8	±8.1	±3.6	±6.8

9.0 to 39.5 mm, with a mean of 25.9 mm (table 11). These values are difficult to interpret as few studies have reported upper arm skinfold measurements of elderly women; hence, normative data have not been established for predicting the degree of obesity from such measurements of this age group.

Percentage body fat was calculated from the abdominal skinfold, abdominal circumference, and bideltoid diameter, according to the regression equation of Young (77) and the formula of Rathbun and Pace (60). Percentage body fat ranged from 30.7% to 42.8%, with a mean of 35.9% (table 11). Mean fat-free mass was calculated on the basis of Day 8 body weight measurements, and was 41.4 kg, with a range of 31.5 to 51.7 kg (table 11). Again, normative data have not been established for the conversion of either of these measurements to the degree of obesity in elderly women.

Consolazio et al. (97) cautioned that all anthropometric measurements should be made early in the morning upon rising, so that the effect of variation in the state of hydration could be minimized. The fact that measurements of Strathcona Place women were carried out at mid-morning perhaps overestimated the readings.

Degree of Obesity

Table 12 summarizes the relationship among several anthropometric variables, as to their effectiveness in predicting the degree of obesity in the Strathcona Place

TABLE 12: Pearson Correlation Coefficients for Various Anthropometric Variables for Strathcona Place Women (N=15)

	% BODY FAT	UPPER ARM SKINFOLD
BODY WEIGHT (Day 1)	+0.2894 (0.148) *	+0.6749 (0.003)
PONDERAL INDEX	-0.4311 (0.054)	-0.9001 (0.001)
UPPER ARM SKINFOLD	+0.2498 (0.185)	

*Level of probability

subjects. Percentage body fat did not correlate well with any of the other measurements which might be indicative of fatness--body weight, ponderal index or upper arm skinfold thickness. The lack of positive correlation with body weight was not surprising, as weight, per se, does not provide an indication of body composition. There was a negative correlation between percentage body fat and ponderal index, indicating that the larger the percentage body fat, the greater the risk of obesity; however, the correlation was not significant. Womersley and Durnin (98) also found ponderal index to be a poor index of obesity, in females aged 17-72 years. The percentage body fat might have been expected to correlate well with upper arm skinfold because both these measure attempt to assess the amount of body fat; however, a significant, positive correlation was not observed.

Among Strathcona Place women, upper arm skinfold thickness correlated positively ($P<0.01$) with body weight (table 12). In addition, there was a very strong negative correlation between upper arm skinfold and ponderal index--correlation coefficient of -0.9001 ($P<0.001$)--(table 12), indicating that a large upper arm skinfold thickness was associated with a high risk of obesity. In the present study, skinfold measurements of the upper arm were performed so that data could be correlated with data obtained by Nutrition Canada; however, Young (77) observed that percentage body fat among elderly women was predicted more accurately by skinfold measurements of the thoracic region, than those of the extremities. Upper arm skinfold may not be an appropriate measurement for prediction of body fat in older women. Among females, skinfold thickness measurements provide a better indication of body fatness than other anthropometric measurements (52); yet, the decline in skinfold compressibility with age may affect the validity of skinfold measurements in predicting body fat (53). On the basis of the mean ponderal index of 11.8, Strathcona Place subjects would be classified as moderately obese.

<u>Comparison of Anthropometric Measurement Results with Other Data</u>

The mean body weight measured on Day 1 was 64.6 kg, and was similar to that obtained for Alberta women studied in the Nutrition Canada survey--67.9 kg. Analysis of variance revealed no significant difference between the two groups (P>0.05) (table 6). In addition, the mean ponderal index of 11.8 was statistically similar to the mean of 11.6 reported by Nutrition Canada for Alberta women (P>0.05) (table 6).

The mean skinfold measurement of the upper left arm was 25.9 mm, slightly higher than the mean of 22.6 mm obtained for Alberta women studied by Nutrition Canada. There was no significant difference between the two groups regarding the upper arm skinfold measurement (P>0.05) (table 6).

Mean percentage body fat in the present study was 35.9%, and was lower than that reported by Young (59), who found 44.6% body fat in her elderly subjects. The mean age of the women in her study was lower, 64.5 years, compared with 73 years; thus, the older subjects in the present study might be expected to have a higher percentage, since fat-free mass declines with age.

Measurement of total body potassium yielded body fat estimates of 44.7% and 49% in two different studies (41,46). These results are considerably higher than the mean of 35.9% found in the present study. Data from research employing total body water determinations to measure percentage body fat are more comparable with results of the present study. Edelman et al. (56) reported a mean of 36.5%, whereas, Hume and Weyers (57) reported 32% body fat, compared with 35.9% among Strathcona Place women. Results obtained using the chemical dilution principle with subjects aged 62-68 years (58) were similar to data in the present study: 37.5% and 35.9%, respectively. It would appear that the choice of technique exerts an influence upon the results obtained and must therefore be given consideration when interpreting results and establishing normative data.

__Evaluation of Anthropometric Measurements in Predicting Body Fatness__

The difficulty in obtaining reproducible results has been cited as a major disadvantage involved with anthropometric measurements (78). In this study, an attempt to minimize error was made by using trained individuals to perform all measurements, and by using the two-handed pinch technique for skinfold measurements as suggested by Damon (76). The skinfold technique has the advantage of ease of use by the researcher and a minimum of inconvenience for the subject. These features are especially important when studying older subjects, as subjects may find it difficult to travel to a remote site, such as a laboratory, for measuring; thus, measurements must be taken at the place of residence.

Although skinfold measurements of the upper arm are more conveniently done than measurements at other sites, Young (77) observed that skinfold measurements of the thoracic region actually predicted percentage body fat more accurately than measurements of the extremities.

Body density or specific gravity may be estimated from skinfold measurements by use of multiple regression equations. This method of estimation is both practical and convenient (99). Young (77) proposed a regression equation to predict specific gravity that incorporated the measurements of abdominal skinfold, abdominal circumference and bideltoid diameter (appendix, table 14). She considered this equation to be the most predictive of the three she developed for use with elderly women. To convert specific gravity to percentage body fat, Young used the Rathbun-Pace equation (60); however, Rathbun and Pace gave no indication of environmental temperature when they reported human specific gravity; thus, their formula has been challenged.

Equations proposed by Keys and Brozek (100), Siri (62) and others (101,102) are more widely recognized. They use body density, rather than specific gravity, for conversion to percentage body fat, since environmental temperature is controlled. In this study, the multiple regression equation developed by Young (77) was used, as no other research group has proposed a regression equation exclusively for use by senior women. Since Young employed the Rathbun-Pace formula for conversion to percentage body fat, the discretionary selection of another formula would not be justified; thus, this formula was used in the present study.

Young's equation proved to be a convenient and acceptable technique for estimating body fat. While the dearth of normative data prevents the direct translation of percentage body fat to degree of obesity, data on body fatness will help to establish norms for elderly women.

B. Energy Balance

Mean energy intake and expenditure of the Strathcona Place subjects were 1246 kcal and 2153 kcal, respectively. Mean energy balance was predicted by subtracting the mean total 7-day intake from the mean total 7-day expenditure and dividing by the energy equivalent of 7700 kcal for one kg of body fat. The result was a predicted mean loss of 0.8 kg of body fat, in contrast to an actual gain in body weight over the seven days of 0.2 kg (table 4). This discrepancy of 42%

in favour of energy expenditure over intake was not reflected in the assessment of weight changes described by subjects in the questionnaire.

Use of diuretic medication can cause large fluctuations in body weight, as fluid is lost or retained in response to the drug. Although two subjects were taking diuretics, in both cases, they administered the drugs at the same times, relative to the times of measurement of body weight at the beginning and end of the study period. Large differences, however, were noted between the actual change and the predicted change in body weight for these subjects. Subject 04 had a predicted change of -1.46 kg, but an actual change of +0.2 kg. She was unavailable for body weight measurement on Day 8, and her weight was obtained five days later. The unavoidable delay in performing her second body weight measurement could have been an etiological factor in the difference observed in her data. The predicted weight change for subject 10 was -0.68 kg; her actual change was +1.95 kg.

Durnin et al. (15) and Salvosa et al. (19) also reported energy expenditures which exceeded intake; however, the differences were much less--4.7% and 6.9%, respectively, compared with 42% in the present study. The mean percentage body fat of 35.9% for subjects in the present study does not indicate extreme thinness which might be expected if subjects were consistently under-eating and over-expending.

The large difference between energy intake and expenditure could be explained if subjects did not record all food eaten. This seems unlikely, since their food patterns were logical and appeared to be complete. They seemed to understand how to use the dietetic balance, and the majority of subjects felt that they had achieved proficiency in its use. The mean intake of 1246 kcal/day consumed by subjects in this study was similar to the 1421 kcal/day reported for the 55 Alberta subjects assessed in the Nutrition Canada survey; thus, their intake appeared to be representative of intakes of elderly women of similar age.

Subjects may not have recorded all activities or may not have described them as accurately as possible. Several women were not enthusiastic about using the tape recorder. Participants stated that it was difficult to record all activities; thus, they may only have recorded more major shifts in activity and not short periods of time when they were less active. They may have been more sedentary than the results indicate. From their activity records, many subjects seemed to lead very busy lives; however, quite possibly the intensity of activity undertaken was reduced. Calculations of energy expenditure were based on values from the literature. Since data on elderly women is woefully deficient, many of these values were obtained from studies of younger females and fewer than ten subjects per study. Since fat-free mass declines with age, the energy expended in various tasks may have been overestimated.

The tables used to calculate activity (82-84) included basal metabolism as well as activity, and this could have introduced an additional error. When energy expenditure was calculated using figures which excluded the basal factor (96), no consistent change was evident. As figures excluding basal are available for only a few activities undertaken by older women, many activities had to be calculated using expenditure data extrapolated from other activities. This method was thought to introduce an even larger error, and was not used.

Among the women studied at Strathcona Place, there was a very positive feeling towards their living accommodation. Although some found the suites confining, facilities such as the whirlpool, exercise bicycles and shuffleboards provided the opportunity for many types of activity. These were greatly appreciated and well-used by many tenants. Subjects seemed to be especially active, despite the fact that they were living in small apartment units. They used not only the facilities within their own apartment complex, but participated actively in the social and recreational activities in the nearby recreation centre. Many subjects estimated that time formerly spent doing household tasks was now spent in recreation. The atmosphere within Strathcona Place and proximity to the recreation centre seemed to promote physical and emotional vitality among tenants. If recreation facilities had not been so readily available and subjects less well motivated to participate in recreational activities, the elderly women studied might have demonstrated different patterns of activity, and expended much less energy.

SUMMARY AND RECOMMENDATIONS

1. Energy balance was studied in a group of fifteen elderly women living in a high-rise apartment complex designed for senior citizens. Subjects had a mean age of 73 years, height of 156 cm, and body weight of 65 kg.
2. A weighed food record was used to obtain data on nutrient intake. It was found to be a feasible method for collecting intake data from elderly women during normal daily routines. The mean 7-day daily energy intake was 1250 kcal, considerably less than the recommendation of 1500 kcal for elderly Canadian women (12). Low intakes of other nutrients, notably calcium, also were identified. As expected with a group composed of volunteer individuals, interest and enthusiastic cooperation declined during the latter days of the study period; therefore, data were analyzed to investigate possible statistical similarities between 3-day and 7-day intake data. No significant difference was found between mean daily intake for the first three days when compared with the entire 7-day period; thus, the 3-day weighed food record would appear to be feasible, and perhaps the preferable method for assessment of energy intake. As several subjects in this study indicated weekend variation in food patterns, three consecutive weekdays may be the most appropriate for future dietary investigations of elderly women.
3. Subjects recorded all activities undertaken for seven

days concurrently with the intake data. Activity data were collected by use of a tape recorder, rather than the more usual written record. Activities undertaken by the women were categorized according to energy intensity. Subjects spent a mean of 1120 minutes in sedentary pursuits. Light to moderate activities accounted for 230 minutes of the day, while 90 minutes were devoted to more strenuous tasks. The mean 7-day daily energy expenditure was 2150 kcal, which exceeded intake by 42%.

4. A tape recorder and digital watch were used to collect the activity data. The majority of women studied found that this furnished an easy and convenient technique for recording activities. Some subjects, however, were reluctant to use a new piece of equipment, and consideration must be given to such individuals. Providing additional time for subjects to achieve familiarity with equipment, or allowing enough flexibility so that subjects unwilling to use the prescribed method could use a modified procedure, should increase accuracy of data collection. The researchers were hopeful that use of the tape recorder would increase accuracy; however, several other sources of error remained. Subjects collecting activity data over a 7-day period did not precisely record small changes in activity; thus, the more major and energy intensive changes were noted, and consequently, calculated

expenditure may have been overestimated. In addition, error was introduced when values were extrapolated from the literature and used to calculate the energy cost of activities. Since table values were based on data obtained from young adults, this error may have been magnified further.

5. A number of anthropometric measurements were performed to assess body composition and degree of obesity. There was a mean increase in body weight of 0.2 kg over the 7-day period, from 64.6 to 64.8 kg. Mean upper arm skinfold thickness was 25.9 mm. The mean ponderal index of 11.8 indicated a moderate risk of obesity. Percentage body fat was estimated using a regression equation developed by Young (77) which employed the measurements of abdominal skinfold, abdominal circumference and bideltoid diameter. Results indicated a mean of 35.9% body fat among Strathcona Place women. Use of a regression equation utilizing a number of anthropometric measurements provided a relatively easy method for estimating percentage body fat. Further research is needed to assess the validity of regression equations for predicting percentage body fat among elderly women.

6. Comparison of the data from the present study with the data on Alberta women studied by the Nutrition Canada survey showed statistical similarities between the two groups, with respect to age, height, weight, upper arm skinfold thickness, ponderal index and energy intake.

7. Energy intake was significantly less than the calculated energy expenditure, and subjects appeared to be over- rather than under-weight; thus, the error in determining energy balance would seem to reside in the method used to collect the expenditure data. Individual calibration of energy cost for a number of activities could help to reduce this error.

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APPENDIX

TABLE 1
Newsletter Notice

? ? ?

DID YOU KNOW:

- that 80% of Canadian women over age 65 are overweight?

- that the average Canadian woman over age 65 only eats as much food as a 4 year old - about 1400 calories?

Would you like to know the reasons for these facts and how <u>you</u> compare with the "average Canadian woman over age 65?" We, in the Home Economics Faculty at the university are also interested in how Edmonton women compare with women in the rest of Canada.

So, please join us for coffee and a discussion of this topic anytime between 1:00 and 3:00 P.M. on the afternoon of Tuesday, October 17 or anytime between 10:00 A.M. and noon on the morning of Wednesday, October 18 in the Party Room. If you cannot make it at these times, please leave your name on the poster, so that we can arrange a more convenient time for you to meet with us.

TABLE 2
Study Description

A Study of Energy Intake and Energy Expenditure in Women Aged 65 and over

A greater percentage of Canadians now belong to the population group over age 65. For convenient and social purposes, an increasing number of high-rise apartment complexes are being built in order to house senior citizens. According to the recent nationwide study, "Nutrition Canada", a definite need for further study has been shown, particularly the food and activity patterns of this segment of the population.

We, in the Nutrition Division of the Faculty of Home Economics at the University of Alberta, propose to study typical dietary intake and activity patterns of women aged 65 and over who have moved into this new type of housing. We wish to obtain an estimate of energy intake and energy expenditure and hope to compare this with results from women of similar age still residing in single-unit dwellings. The result of this research could be helpful in making future recommendations on energy needs for older women in Canada. To assist us in our calculations of energy expenditure, we are interested in determining changes in body composition with aging, and thus, will make several anthropometric measurements to estimate the percentage body weight as body fat.

The procedures will require that each participant weigh <u>all</u> foods and beverages consumed and record all activities with the use of a tape recorder for a period of 7 days. Participants will be provided with, and instructed in the use of equipment, and will be visited daily to clarify any problems which might arise. In addition, a short questionnaire will be given in order to give us an indication of the participant's present health status, as well as the usual food and activity patterns. Several body measurements - body weight, height, upper-arm and abdominal skinfolds, abdominal circumference and shoulder breadth will provide a prediction of the percentage of body fat.

Upon completion of the study, a copy of the results will be sent to the participant. This will include an assessment of the daily intake of all major nutrients as well as advice regarding the quality of the diet consumed.

The data and information derived from each individual participant will be held in confidence by the members of the research group.

TABLE 3

Subject Instructions: Food Intake Record

__WHEN RECORDING FOOD INTAKE:__

1. Write down __everything__ you eat or drink.

2. __Describe the kind of food eaten__: For instance, if you eat cereal, write cornflakes or oatmeal; if bread, whether it is brown, rye, whole wheat, etc. A brand name would also be helpful.

3. __Describe how each food is prepared__: For example, write spaghetti and meat sauce, commercially-canned, heated; sirloin steak with bone, broiled, and trimmed of fat; orange without peel, raw.

4. __Use of dietetic balance__:
   (a) Set balance to zero.
   (b) Place weighing container on balance and return zero to the red line.
   (c) Place portion of food to be eaten on container.
   (d) Record weight on chart. The units on the dietetic balance are grams.
   (e) For the next food item to be placed on the same container, zero balance, and continue with steps (c) and (d).
   (f) For another food item to be placed on a separate container, repeat steps (a) to (d).

5. When you eat 2 or more foods together, record everything.
For example:
2 slices white bread - 60 gm.
processed skim milk cheese spread - 45 gm.
1 leaf of lettuce - 20 gm.
__OR__
coffee - 1 cup
2% milk - 30 gm.

6. Sometimes, foods like sugar and butter or margarine are eaten in small amounts, but many times throughout the day. You may find it easier to use this method for such foods: (a) weigh the food and container together (e.g. butter and dish)
   (b) record this weight
   (c) at the end of the day, again weigh the food in the container
   (d) again record this weight

7. Mixed dishes: For example, with casseroles or salads, include the recipe, using household measures or weights to describe ingredients. Then weigh and record the portion to be eaten.

8. Uneaten food which has been weighed: If all weighed food is not eaten, weigh the left-over portion or wastes (for example, steak bones, meat fat, apple cores, etc.) by using the same procedure described in #4. Record this amount too.

9. Eating away from home: When you are eating away from home, there is no need to weigh the food eaten; however, we do ask that you use the small cards provided to record what you ate. Estimate amounts by weight or household measure.

REMEMBER: We are interested in your typical, everyday food intake. We would like to know what you usually eat; therefore, your food record should reflect your usual diet, foods ordinarily consumed. Changing your eating habits because you are keeping this record will make the study worthless. We certainly appreciate all your help.

Should you run into difficulty or have any questions, please do not hesitate to call either:

Margaret Ng	432-3833	(office)
	436-8088	(home)
OR		
Glenda MacWilliam	432-4925	(office)
	469-9217	(home)

TABLE 4
Data Sheet for Food Intake

FOR OFFICE USE ONLY:

NAME______________________ DATE__________

	TIME	BEVERAGES & FOODS EATEN	WEIGHT OF SERVED PORTION	WEIGHT OF LEFTOVER PORTION

TABLE 5
- Subject Instructions: Activity Record

ACTIVITY RECORD

Use of the tape recorder

1. To record:
   (a) Press the orange button, marked REC, on the side of the recorder.
   (b) You will know you are recording when you see the red light shine on the front of the recorder, marked BATT
   (c) State the time read from the digital watch, then the activity you are performing.
   (d) Speak in the direction of the microphone, marked MIC, on the front of the recorder.

2. To stop recording:
   (a) Press the button, marked STOP, on the top of the recorder.

3. If you come to the end of one side of the cassette tape:
   (a) Pull down the front of the recorder, and remove the cassette.
   (b) Turn the cassette over and place it back in the same way you removed it.
   (c) Push the front of the recorder back into place.

If the red light, marked BATT, does not shine when you are recording, please contact one of the people listed on the food intake sheet.

RECORDING ACTIVITIES

Please record all changes in activity, which take place for 1 minute or longer. Describe, in as much detail as possible, the type of activity you are performing under each category.

Examples:

1. Lying down - whether resting or sleeping.

2. Sitting - whether listening to music, reading, eating,

watching TV, playing cards, sewing or knitting, etc.

3. Standing - whether standing quietly, ironing, floor sweeping, peeling vegetables, light meal preparation dressing, washing or other personal necessities.

4. Moderate activities - whether dishwashing, hanging out wash or hand-washing, cleaning cupboards, dusting, walking at a slow pace or driving a car, etc.

5. Heavy activities - whether kneading dough, stair-climbing gardening, kneeling or bending, bed-making, vacuuming, window cleaning, polishing a floor, brisk walking, dancing or sports, etc.

TABLE 6
Interview Questionnaire

NAME____________________ AGE_____ HEIGHT_____ WEIGHT_____

ADDRESS_________________ PHONE_______ HOURS TO AVOID_____

SEASON: (a)spring (b)summer (c)fall (d)winter DATE_______

1. Type of dwelling: (a)single (b)multiple If (b) specify:

2. Type of household: (a)family (b)other If (b) specify:

3. Type of cook stove: (a)electric range or rangette (b)natural gas range (c)hot plates (d)wood/coal/oil (e)primitive (f)other

4. Where do you usually store perishable foods?
   i. (a)refrigerator (b)ice box (c)root cellar (d)other
   ii. (a)refrigerator and freezer (b)freezer (c)locker (d)other

5. Number of residents in dwelling:
   If this varies, specify:

6. Relationship of residents to interviewee:
   (a)interviewee (b)spouse (c)child (d)stepchild (e)parent (f)other relative (g)not related
   Highest school grades obtained: 01-13 grades; 21-29 (after high school other than college) - #years; 30 - college; blank - preschool

NAME	REL	DATE OF BIRTH			HSG	PLACE OF BIRTH
		DAY	MONTH	YEAR		
Interviewee						

7. Residence of interviewee (yrs): (a)Edmonton (b)Alberta (c)Canada (d)other country* *specify country__________

8. Total annual family income (from all sources): (a)under $2,000 (b)$2,000-$3,999 (c)$4,000-$5,999 (d)$6,000-$9,999 (e)$10,000-$14,999 (f)$15,000 and over -

9. Where do you do most of your shopping? (a)supermarket (b)neighbourhood store (c)open market (d)other If (d) specify:

10. Who usually decides what food to purchase? (a)interviewee (b)spouse (c)interviewee and spouse (d)other adult(s) (e)interviewee and other adult(s)

11. Weekly amount spent on food bought for home consumption:

12. Who usually prepares food? (a)interviewee (b)spouse (c)interviewee and spouse (d)other adult(s) (e)interviewee and other adult(s)

13. Do you eat food or drink beverages with other people? (a)more than 3 times a day (b)3 times a day (c)2 times a day (d)once a day (e)several times a week (f)weekly (g)monthly (h)less than once a month

14. How often do you routinely eat food or drink beverages away from home? (including short visits with friends or relatives) (a)daily (b)6 days a week (c)5 days a week (d) 4 days a week (e)3 days a week (f)2 days a week (g) several occasional times a week (h)weekly (i)several occasional times a month (j)monthly (k)less than once a month If (a)-(f), (i)only A.M. (ii)only noon (iii)only P.M. (iv)only evening (v)only late evening (vi)A.M. and noon (vii)A.M. and evening (viii) noon and evening (ix)noon and P.M. (x)evening and late evening (xi)one of the above and several occasions a week at other times (xii)varies each day

15. What times do you eat food or drink beverages throughout the day?

16. Does your eating pattern change on weekends? (a)yes (b)no If (a) specify:

17. Do you wear dentures? (a)no (b)upper arch only (c)lower arch only (d)both

18. If full denture has been in place, it has been worn for how long? (a)12 mos. or less (i)upper (ii)lower (b)2 yrs or less (i)upper (ii)lower (c)5 yrs or less (i)upper (ii)lower (d)more than 5 yrs (i)upper (ii)lower (d)not applicable

19. Do you have any difficulty in biting or chewing severe enough to interfere with eating? (a)yes (b)no

20. Have you had any medical condition within the past 5 years which has caused changes in diet or changes in exercise and activity patterns? (a)yes (b)no If (a) specify: 1 - present; 2 - within past year; 3 - 1-5 years ago

MEDICAL CONDITION	DIET CHANGE	ACTIVITY CHANGE	TIME

21. Do you take any medicines, drugs, vitamins, etc.? (a)yes (b)no, not at all If (a) specify: 1-regularly and/or 2-within past 3 days; 3-occasionally

Vitamin preparations____ Type:
Mineral preparations____ Type:
Tonics____
Cough medicines____
Sedatives or hypnotics____
Tranquilizers____
Antibiotics____
Anti-convulsants____
Dilantin____
Anti-hypertensives____
Anti-coagulants____
Cardiac medication (digitalis, etc.)____

Appetite depressants____
Amphetamine, dexedrine, or other CNS stimulants____
Diuretics____
Cholesterol-depressants____
Anti-diabetic agents____
Thyroid____
Anti-thyroid agents____
Female hormones____
Other hormones____
Other medications____ (including injections)

22. Do you believe you eat a nutritionally well-balanced diet? (a)yes (b)no (c)don't know

23. What was your weight at age 25? _____ How has your weight changed over the years since then?

24. Have you ever considered yourself overweight? (a)yes (b)no

25. Have you followed any type of a weight-reducing diet within the past year? (a)yes (b)no If (a) specify: Type or Name

26. Has your weight changed significantly (>10% of body weight) in the past 6 mos.? (a)yes (b)no
If (a), how much weight did you gain or lose? _______
Any significant reason known for the change? (e.g. illness, dieting, etc.)

27. How often are you involved in strenuous physical activity at home? (a)daily (b)several times a week (c)weekly (d)monthly (e)less than once a month
Type:
Duration:

28. Do you participate in physical activity, other than walking, outside your home?
Winter: (a)yes (b)no If (a) specify: (i)daily
(ii)several times a week (iii)weekly
(iv)monthly (v)less than once a month
Type:
Duration:
Summer: (a)yes (b)no If (a) specify: (i)daily
(ii)several times a week (iii)weekly
(iv)monthly (v)less than once a month
Type:
Duration:

29. How often do you engage in walking activity outside your home?
Winter: (a)daily (b)several times a week (c)weekly
(d)monthly (e)less than once a month
Usual distance walked:
Summer: (a)daily (b)several times a week (c)weekly
(d)monthly (e)less than once a month

Usual distance walked:

30. Is your activity restricted by any chronic condition?
(a)yes (b)no If (a) specify:

31. Would you consider yourself an active individual for your age? (a)yes (b)no

32. Do you consider yourself more active, on a day-to-day, basis, since you moved into your present accommodation in Strathcona Place?
Winter: (a)yes (b)no If (a) explain how:

Summer: (a)yes (b)no If (a) explain how:

33. Do you think you should be more active than you are at present? (a)yes (b)no

TABLE 7
Participation Consent Form

CONSENT FOR NUTRITIONAL STUDY

I, ________________, hereby agree to undertake a study of my energy intake and energy expenditure. I understand that I will be required to weigh all foods and beverages consumed for 7 days. I understand that I will be required to record all my activities with the use of a tape recorder during this period.

I understand that I will undergo several anthropometric measurements - body weight, height, upper arm and abdominal skinfolds, abdominal circumference and shoulder breadth. In addition, I understand that I will be required to answer a questionnaire pertaining to my health status and usual food and activity patterns.

In agreeing to such a procedure, I understand that I may withdraw at any time; I waive any legal recourse against the University of Alberta from any and all claims resulting from this study.

DATE:________________

PARTICIPANT:____________________________
Signature

WITNESS:________________________

TABLE 8

Data Sheet for Summarizing Energy Expenditure (E.E.)

BODY WEIGHT__________

NAME:_______________ **DATE:**____________ **I.D.:**________

CLASS	**ACTIVITY**	**TIME**	**DURATION**	**KCAL/KG/MIN**	**TOTAL E.E.**

TABLE 9
Energy Cost of Specific Tasks Reported by Passmore and Durnin (84)

ACTIVITY	KCAL/KG/MIN	CLASS
Sleeping, lying down	basal metabolism	1
Sitting quietly (reading, radio, T.V.)	0.0198181	2
Sitting - eating	0.0230769	2
Knitting (23 stitches/min)	0.0234	2
Sewing (30 stitches/min)	0.228	2
Hand sewing	0.0295454	2
Simple work sitting	0.020238	2
Standing quietly	0.0221818	2
Sewing with machine	0.0363636	3
Personal necessities if > 10 min	0.0297272 (1.5 X sitting quietly)	3
Sweeping floors	0.034	3
Stirring	0.0357142	3
Typing	0.0327272	3
Bringing in the wash	0.0392857	3
Personal necessities if ≤ 10 min	0.0396363 (2 X sitting quietly)	4
Washing small clothes	0.0461538	4
Scrubbing floors	0.045	4
Taking out, and hanging out the washing	0.05625	5
Scrubbing while standing	0.0604166	5
Kneading dough	0.0507692	5
Mopping	0.0525	5
Wringing wash by hand	0.0676923	5
Polishing the floor	0.0571428	5
Bed making, bed stripping	0.0675	5
Up, down stairs (no load)	0.1016949	5
Walking	$E_W = 0.047(W) + 0.2$ (W = weight in kg)	5

TABLE 10
Energy Cost of Activity Groups Reported
by Durnin and Passmore (83)

Energy Expenditure in Domestic Tasks
Rates for Women (kcal/min/55 kg)

I	1.0-1.4	knitting, sewing
II	1.5-1.9	floor sweeping, ironing, peeling potatoes, preparing vegetables, shoe cleaning
III	2.0-2.9	carpet sweeping, clearing out fireplace and setting fire, cooking, preparing a meal, setting table, dishwashing, washing small clothes, hanging out washing, washing floors, cleaning cupboards, dusting, polishing silver
IV	3.0-3.9	bed-making, hoovering and moving furniture tidying a room, polishing a floor with mop window cleaning, chopping fire-wood, getting in coal, shopping with light load
V	4.0-	beating carpets, scrubbing floors, furniture polishing, washing clothes by hand, shopping with heavy load

TABLE 11
Data Sheet for Basal and Maintenance Metabolism Calculations (85,86)

NAME________________

I.D.________________

NORMAL BASAL METABOLISM

HEIGHT__________

WEIGHT__________

AGE__________

$$KCAL = 65.8 \times W^{.75} [1 + 0.004(30-a) + 0.018(s-42.1)]$$

where: W = actual body weight

a = actual age

s = actual specific stature

(ht(cm)/$W^{.33}$)

Basal energy needs = ______ kcal

Maintenance energy requirement (4/3 basal) = ______ kcal

TABLE 12
Activity Categories

Classes of Activities	kcal/kg/min
1	< .019
2	.019-.029
3	.030-.039
4	.040-.049
5	≥ .050

TABLE 13
Data Sheet for Anthropometric Measurements

NAME:________________ DATE:____________ I.D.:________

BODY COMPOSITION MEASUREMENTS:

WEIGHT _____kg _____lbs

HEIGHT _____cm _____in

PONDERAL INDEX (ht"/$\sqrt[3]{wt}$ lbs) _______

UPPER ARM SKINFOLD (left)____mm ____mm ____mm $\bar{X}$=____mm

(1) Abdominal skinfold (right)____mm ____mm ____mm $\bar{X}$=____mm

(2) Abdominal circumference _____cm

(3) Bideltoid diameter _____cm

SPECIFIC GRAVITY=1.00713-.005253(1)-.007297(2)+.0024155(3)

=1.00713- - +

= ______

PER CENT BODY WEIGHT AS FAT

= 100(5.548/specific gravity-5.044)

= ______ %

WEIGHT OF FAT = _____kg; WEIGHT OF FAT-FREE BODY = _____kg

TABLE 14
Summary Sheet for Nutrient Intake

	RECOMMENDED INTAKE FOR CANADIAN WOMEN OVER 65	DAY OF STUDY						
		1	2	3	4	5	6	7
ENERGY INTAKE (kcal)	1500							
PROTEIN (g)	41							
CALCIUM (mg)	700							
PHOSPHORUS (mg)	700							
IRON (mg)	9							
VITAMIN A (IU)	3700							
THIAMINE (mg)	1.0							
RIBOFLAVIN (mg)	1.2							
NIACIN (mg)	13							
VITAMIN C (mg)	30							
ENERGY EXPENDITURE (kcal)								