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DIETARY PATTERNS AND INCIDENCE OF DEPRESSION IN A COHORT OF COMMUNITY-DWELLING OLDER CANADIANS

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Abstract: *Objectives:* To investigate the association of dietary patterns with a 3-year incidence of depression among healthy older adults. *Design:* Multiple logistic regression models adjusted for age, sex, marital status, smoking, education, total energy intake, physical activity, body mass index, hypertension, functional autonomy, cognitive functioning, social activities, and stressful life events. Energy and macronutrient intakes were also analyzed as potential predictors of depression. *Setting:* Cities of Montréal, Laval, and Sherbrooke in Quebec, CA. *Participants:* Community-dwelling older adults, free of depression at baseline (N=1,358, 67-84 y), followed for 3y in the Québec Longitudinal Study on Nutrition and Aging (NuAge). *Measurements:* Dietary patterns derived from principal components analysis of three 24 h-recalls at baseline, and depression incidence as measured by the 30-item Geriatric Depression Scale (≥11) and/or use of antidepressants at follow-up years. *Results:* 170 people (63% women) became depressed over the 3 years. People in the highest tertile of adherence to the "varied diet" had lower risk of depression before adjustment (OR 0.58, 98% C.I. 0.38-0.86) but not significant once age and sex were controlled. No other dietary pattern was associated with the incidence of depression. The highest tertile of energy intake was associated with lower depression incidence after controlling for all confounders (OR 0.55, 95%CI 0.34-0.87). *Conclusion:* Among healthy older adults, dietary patterns do not appear to be related to depression. Those who eat less, however, possibly reflecting declining health, are at higher risk of becoming depressed.

Key words: Dietary patterns, older adults, depression, longitudinal, principal component analysis.

Introduction

Depression is one of the most prevalent and costly of all mental health disorders and a leading cause of disability (1). Reports on the prevalence of clinically significant depressive symptoms among healthy older adults range from approximately 8% to 16% (2). By 2020, depression may become second only to heart diseases in its contribution to the global burden of disease as measured by disability-adjusted life years (3). In addition, depression in old age is linked with high morbidity and mortality rates (2, 4) and increased risk for cognitive decline, stroke, low bone mineral density, fractures, loss of appetite, poor quality of life, physical disability, and impairments in activities of daily living (5-9).

Diet and physical activity are two modifiable factors that are associated with depression in the general population (10-12) and in late-life (13, 14). Nutritional studies on depression have focused mainly on fish, long chain n-3 PUFAs, folate, and other B vitamins (15), however. Increasingly, dietary pattern analysis is seen as complimentary to traditional analysis of nutrients (16). In longitudinal (17-19) and cross-sectional (20, 21) studies of middle-aged adults, dietary patterns were associated with depression or depressive symptoms. Our study is, however, to our knowledge, the first to explore this relationship longitudinally in older men and women. Therefore, our primary objective was to examine the associations of dietary patterns from principal component analysis, and, secondarily, to examine energy and macronutrient intakes, in relation to the incidence of depression over a three-year follow-up period in a large cohort of initially healthy older adults.

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Methods

Study population

The Québec Longitudinal Study on Nutrition and Aging (NuAge) is a 4-year observational study of 1,793 men and women, free of disabilities in activities of daily living, and without functional or cognitive impairment at recruitment living in Montreal, Laval and Sherbrooke (QC, CA). Detailed information on the study population was published elsewhere (22). Baseline data collection occurred between December 2003 and March 2005. Participants provided informed consent. Ethics was approved by the Geriatric University Institutes of Montréal and Sherbrooke.

Participants with depression (Geriatric Depression Scale (GDS) ≥11 or antidepressant medication use) at baseline (n=271), missing/invalid GDS scores at baseline or at all three follow-up assessments (n=195), and invalid or missing dietary information at baseline (n=103) were excluded. The final sample size for this study was 1,358 individuals (50.4% women, mean age ± SD 74 ± 4 years). Follow-up data were available for 3 y for 79%, 2 y 15%, and 1 y 6%.

Dietary assessment and Dietary Patterns at baseline

Mean energy and nutrient intakes at baseline were obtained from three non-consecutive 24-hour dietary recalls, including one during a weekend day, by research dietitians and analyzed using the CANDAT software and the 2007b Canadian Nutrient File (23). This provides precise estimates of usual intakes for many nutrients similar to those obtained by a 7-d dietary record, with r values above 0.90 (24).

Each food item in the dietary recalls was categorized into one of the 32 categories created according to nutrient profile, culinary use, and existing research (17) (Supplementary Table 1). Dietary patterns were identified using principal component analysis. Components were rotated by orthogonal transformation (varimax rotation). The eigenvalue, scree plot, interpretability of the components, and percentage of variance explained by the components were used to determine the number of dietary patterns to be retained. Factor loadings represent correlation coefficients between the food categories and the dietary pattern. The sum of intakes (in grams) weighted by the category's factor loading yields factor scores for each individual in all three patterns—the higher the person's factor score in a patterns, the greater is the person's adherence to that pattern.

Main Outcome Measure: Depression Incidence

Depression incidence was identified on the basis of scores on the 30-item Geriatric Depression Scale (GDS) ≥11 (25) or new use of antidepressant medication at any year of follow-up. Only three subjects presented scores ≥21, classified as severe depression. At a cut-off score of ≥11, the tool has 84% sensitivity and 95% specificity for clinically diagnosed major depression (25). Medications with the therapeutic classification name, according to the American Hospital Formulary System, as "antidepressants," "miscellaneous antidepressants," "selective-serotonin reuptake inhibitors," and "serotonin modulators" were also used to define depression—benzodiazepine was not included.

Confounders at baseline

Sociodemographic variables are age (y), sex, marital status (married/other), and education (years of schooling). Physical activity was assessed by the Physical Activity Scale for the Elderly (PASE) (26), designed and validated to assess physical activity levels over 1-week. Higher PASE scores indicate higher activity levels (range: 0-793). Smoking status at baseline was measured as smoker/non-smoker.

Health status measures included self-reported hypertension (yes/no), body mass index (BMI, kg/m2), functional status (Functional Autonomy Measuring System (SMAF) scores) (27), and cognition (Modified Mini-Mental State-3MS) (28).

Measurements of social functioning status included reporting of stressful life events, through the question "Have you recently suffered a stressful life event (e.g., personal illness / death of a loved one)?" in the Elderly Nutrition Screening tool (ENS©) (29), and social activities in the preceding month, assessed with the Social Activities Questionnaire from the Elderly Activity Inventory Questionnaire (30).

Statistical analyses

Difference in proportions and means of covariates according to depressive symptoms was assessed using Mantel-Haenszel -test for categorical variables and independent t-tests for continuous variables. Trend association across tertile categories of each dietary pattern was assessed using Pearson's -test for categorical variables and one-way ANOVA for continuous variables.

Factor scores from principal component analysis were categorized into tertiles. Multiple logistic regression models were used to test for associations between the tertiles of dietary patterns and depression, with the lowest tertile as reference. No sex interactions were found between dietary patterns or energy intake and depression. Model 1 was controlled for age and sex. Model 2 was further adjusted for energy intake, marital status, education, smoking status, and physical activity. Model 3 was further adjusted for BMI, hypertension, functional autonomy and cognition, and the final model, for social activities and stressful life events. Separate tests were run for each dietary pattern.

Two-sided p-values less than 0.05 were considered as statistically significant. All statistical analyses were conducted using SPSS software package for Windows version 19.0 (IBM SPSS Inc., Chicago, IL).

Results

Incidence of depression

Among the 1,358 participants, 170 (12.5%) developed depression at some point during follow-up—36 were identified on the basis of antidepressant medication use alone. Seventy six were first detected on year 1 of follow-up, 59 in year 2, and 35 in year 3.

Dietary Patterns

Three dietary patterns were retained from principal component analysis (Supplementary Table 2), accounting for 14.3% of the total variance explained and total initial eigenvalue of 1.36. The first pattern, labelled "varied diet," was heavily loaded by high intakes of fruit, fruit juice and vegetable juice, other vegetables, nuts and seeds, refined and whole grain products, pizza, pasta dishes, chocolate and sweets, snacks items, hot beverages, processed meats, and high-fat dairy. The second pattern, labelled "traditional diet," was heavily loaded by high intake of red meat, butter and fats, alcoholic beverages, potatoes, tubers and starchy vegetables, soups, peas and legumes, desserts, processed meats, high-fat dairy, and low intake of low-fat dairy. The third pattern, labelled "convenience diet," was heavily loaded by high intake of sugar beverages, fried foods, fast foods, mixed dishes, and low intake of fish and seafood, margarine, oils, salad dressings, and leafy vegetables.

Table 1
Participants' baseline characteristics according to tertiles of dietary pattern scores (N = 1,358)

Variables*	Varied Diet				Traditional Diet				Convenience Diet			
	Tertile 1 (low)	Tertile 2	Tertile 3 (high)	p	Tertile 1 (low)	Tertile 2	Tertile 3 (high)	p	Tertile 1 (low)	Tertile 2	Tertile 3 (high)	p
n	453	452	453		452	453	453		453	453	452	
Female	281 (62%)	233 (52%)	171 (38%)	<0.001	283 (63%)	251 (55%)	151 (33%)	<0.001	236 (52%)	260 (57%)	189 (42%)	<0.001
Married	269 (59%)	267 (59%)	284 (63%)	0.470	244 (54%)	266 (59%)	310 (68%)	<0.001	265 (59%)	277 (61%)	278 (62%)	0.600
Smokers	20 (4%)	28 (6%)	37 (8%)	0.070	20 (4%)	29 (6%)	36 (8%)	0.090	25 (6%)	21 (5%)	39 (9%)	0.034
Hypertension	233 (51%)	215 (48%)	195 (43%)	0.040	205 (45%)	216 (48%)	222 (49%)	0.540	200 (44%)	227 (50%)	216 (48%)	0.194
Stressful life event (yes)	167 (37%)	157 (35%)	152 (34%)	0.571	159 (35%)	173 (38%)	144 (32%)	0.130	151 (33%)	169 (37%)	156 (35%)	0.437
Age, years	75.0 ± 4.2	74.3 ± 4.2	73.6 ± 4.1	<0.001	74.4 ± 4.1	74.7 ± 4.4	73.7 ± 4.1	0.002	74.2 ± 4.1	74.5 ± 4.2	74.2 ± 4.2	0.561
Education, years	11.0 ± 4.3	11.6 ± 4.3	12.5 ± 4.8	<0.001	12.3 ± 4.4	12.0 ± 4.8	10.8 ± 4.3	<0.001	12.0 ± 4.4	11.6 ± 4.6	11.6 ± 4.6	0.302
Body mass index, kg/m^2	27.9 ± 4.7	27.9 ± 4.3	27.7 ± 4.3	0.600	27.5 ± 4.5	27.8 ± 4.4	28.3 ± 4.4	0.022	27.5 ± 4.3	27.9 ± 4.6	28.1 ± 4.4	0.168
Level of physical activity, PASE score	100.8 ± 53.3	101.5 ± 50.2	109.8 ± 52.7	0.020	98.6 ± 47.7	101.5 ± 53.8	112.1 ± 54.1	<0.001	103.2 ± 50.8	103.5 ± 52.9	105.5 ± 53.1	0.770
Social activity score	7.1 ± 2.6	6.9 ± 2.6	7.0 ± 2.9	0.444	6.9 ± 2.8	7.2 ± 2.6	6.9 ± 2.6	0.085	7.1 ± 2.6	7.1 ± 2.7	6.9 ± 2.7	0.339
Total energy intake, kcal/day	1603 ± 418	1865 ± 439	2126 ± 532	<0.001	1705 ± 484	1772 ± 445	2121 ± 507	<0.001	1838 ± 490	1805 ± 510	1955 ± 524	<0.001

Notes: Categorical variables are presented as n (%), and continuous variables as mean ± S.D. One-way ANOVA was used for continuous variables and Person's chi-square test for categorical variables. P-value is shown for trend (α-level = 0.05). *PASE = Physical Activity Scale for the Elderly. Social activity score = scores in the Social Activities Questionnaire from the Elderly Activity Inventory Questionnaire.

Table 2
Participants' baseline characteristics according to the incidence of depression over three-years of follow-up (N = 1,358)

Variable*	Depression Incidence		p
	No (n = 1188)	Yes (n = 170)	
Female	578 (49%)	107 (63%)	0.001
Married	729 (61%)	91 (54%)	0.062
Currently smoking	72 (6%)	13 (8%)	0.529
Hypertension	546 (46%)	97 (57%)	0.009
Stressful life events (yes)	392 (33%)	84 (49%)	<0.001
Age, years	74.2 ± 4.2	75.2 ± 4.0	0.002
Formal schooling, years	11.8 ± 4.6	11.3 ± 4.3	0.205
Level of physical activity, PASE scores	106.0 ± 52.8	90.3 ± 45.7	<0.001
Body mass index, kg/m^2	27.9 ± 4.5	27.6 ± 4.3	0.467
Social activity scored	7.0 ± 2.7	6.7 ± 2.6	0.811
Total energy, kcal/day	1887 ± 515	1716 ± 473	<0.001
Protein, % of total energy	16.3 ± 3.4	16.4 ± 3.4	0.919
Total fat, % of total energy	33.0 ± 6.2	32.8 ± 6.0	0.722
Total dietary fiber, g/1000 kcal	10.9 ± 3.9	11.1 ± 3.8	0.581
Vitamin D, mcg/1000 kcal	2.7 ± 1.8	2.9 ± 2.1	0.266
Vitamin C, mg/1000 kcal	64.0 ± 38.5	65.7 ± 35.6	0.594
Folate, mcg DFE/1000 kcal	208.8 ± 54.2	215.5 ± 57.3	0.132
Sodium, mg/1000 kcal	1517.4 ± 419.6	1522.1 ± 400.6	0.891
Calcium, mg/1000 kcal	426.9 ± 156.4	432.4 ± 125.8	0.605

Notes: Counts of depression on the basis of 30-item GDS scores ≥11 or use of antidepressant medication at any time of follow-up. Categorical variables are presented as n (%), and continuous variables as mean ± S.D. Independent t-tests were used for continuous variables and Mantel-Haenszel's -test, for categorical variables. P-value is shown for trend (α-level = 0.05). * PASE = Physical Activity Scale for the Elderly. Social activity score = scores in the Social Activities Questionnaire from the Elderly Activity Inventory Questionnaire.

Population characteristics at baseline

Table 1 presents the baseline characteristics across tertiles of dietary pattern scores. Participants scoring high (tertile 3) in each of the dietary patterns were mostly men. Those with high adherence (tertile 3) to the "varied" pattern had lower rates of hypertension and more years of schooling, while the opposite was observed among those with high adherence to the "traditional" pattern. Physical activity was significantly higher among people in the highest tertile for "varied" and "traditional" patterns, but not for "convenience" pattern. As the adherence to a dietary pattern increased, energy intake also increased significantly ($p < 0.001$).

Those who developed depression at follow-up were more likely to be female, slightly older (75.2 ± 4.0 vs. 74.2 ± 4.2 years), and with lower physical activity scores (90.3 ± 45.7 vs. 106.0 ± 52.8) (Table 2).

Table 3
Associations between tertiles of dietary pattern scores at baseline and incidence of depression over three years of follow-up (N = 1,358)

Dietary Pattern	Tertile 1 (low) Reference	Tertile 2		Tertile 3 (high)	
		OR (95% C.I.)	p	OR (95% C.I.)	p
Varied Diet					
Unadjusted model	1.00	0.79 (0.54-1.15)	0.217	0.58 (0.38-0.86)	0.007
Model 1	1.00	0.87 (0.59-1.27)	0.462	0.70 (0.46-1.07)	0.096
Model 2	1.00	0.92 (0.62-1.37)	0.691	0.82 (0.52-1.29)	0.388
Model 3	1.00	0.94 (0.63-1.41)	0.779	0.86 (0.55-1.36)	0.527
Model 4	1.00	0.95 (0.63-1.42)	0.802	0.86 (0.54-1.37)	0.533
Traditional Diet					
Unadjusted model	1.00	0.98 (0.67-1.43)	0.979	0.73 (0.48-1.09)	0.121
Model 1	1.00	1.00 (0.68-1.46)	0.982	0.88 (0.58-1.35)	0.564
Model 2	1.00	1.02 (0.69-1.50)	0.939	1.00 (0.64-1.56)	0.999
Model 3	1.00	0.96 (0.65-1.42)	0.820	0.97 (0.62-1.52)	0.894
Model 4	1.00	0.92 (0.62-1.37)	0.675	0.96 (0.61-1.52)	0.876
Convenience Diet					
Unadjusted model	1.00	0.80 (0.71-1.55)	0.796	0.90 (0.60-1.35)	0.609
Model 1	1.00	1.01 (0.68-1.49)	0.963	0.95 (0.63-1.43)	0.811
Model 2	1.00	1.02 (0.69-1.51)	0.930	0.97 (0.64-1.46)	0.874
Model 3	1.00	1.01 (0.68-1.50)	0.975	0.91 (0.60-1.38)	0.668
Model 4	1.00	1.00 (0.67-1.48)	0.979	0.89 (0.59-1.35)	0.579

Notes: Values from multiple logistic regression models are presented as Odds Ratio (95% Confidence Interval). Model 1: Adjusted for age and sex. Model 2: Model 1 plus adjustment for total energy intake, marital status, smoking status, education, and physical activity. Model 3: Model 2 plus adjustment for body mass index, hypertension, physical functioning, and cognitive functioning. Model 4: Model 3 plus adjustment for social activities and stressful life events. P-value is shown for trend (α-level = 0.05).

Table 4
Associations between total energy intake at baseline and incidence of depression over three years of follow-up (N = 1,335)

Model	Tertile 1 (≤ 1611 kcal) Reference	Tertile 2 (1612 – 2034 kcal)		Tertile 3 (≥ 2035 kcal)	
		OR (95% C.I.)	p	OR (95% C.I.)	p
n	448	443		444	
Unadjusted	1.00	0.68 (0.47-0.99)	0.046	0.44 (0.29-0.66)	<0.001
Model 1	1.00	0.77 (0.53-1.13)	0.182	0.56 (0.36-0.88)	0.012
Model 2	1.00	0.77 (0.53-1.14)	0.192	0.56 (0.36-0.89)	0.013
Model 3	1.00	0.73 (0.49-1.08)	0.115	0.54 (0.34-0.86)	0.009
Model 4	1.00	0.72 (0.49-1.07)	0.108	0.55 (0.34-0.87)	0.012

Notes: Values from multiple logistic regression models are presented as Odds Ratio (95% Confidence Interval). Model 1: Adjusted for age and sex. Model 2: Model 1 plus adjustment for marital status, smoking status, education, and physical activity. Model 3: Model 2 plus adjustment for body mass index, hypertension, physical functioning, and cognitive functioning. Model 4: Model 3 plus adjustment for social activities and stressful life events. P-value is shown for trend (α-level = 0.05).

Dietary patterns and depression incidence

The association between the three dietary pattern scores at baseline and incidence of depression in the three years of follow-up is shown in Table 3. Compared to the first tertile participants with the highest score for the "varied diet" (tertile 3) were less likely to develop depression (OR 0.58, 95% C.I. 0.38-0.86). However, this association was no longer significant once confounders were controlled. None of the other dietary patterns were associated with depression in this population. Two baseline factors were significantly associated with developing depression in all three patterns: functional autonomy (fully adjusted models, tertile 3 OR 1.08, 95% C.I. 1.02-1.14), and stressful life events (fully adjusted models, tertile 3 OR 1.87, 95% C.I.1.33-2.63) (data not shown).

Macronutrient intake and depression incidence

Tertiles of energy as a measure of total intake and energy adjusted macronutrients as a measure of diet quality were examined in relation to incidence of depression. A multivariate logistic regression analysis indicated a strong protective effect of energy intake (Table 4). Those with higher caloric intakes (top tertile, ≥2035 kcal) were almost 50% less likely to develop

depressive symptoms over the three years of follow-up even after controlling for confounding variables. Modeling with energy intake as a continuous variable in increments of 100 kcal yielded similar results in a fully adjusted model. There was no significant association between depression incidence and protein or fat intakes as a percent of energy (data not shown).

Discussion

In this longitudinal study, dietary patterns are not associated with the incidence of late-life depression over three years of follow-up in a large cohort of generally healthy older Canadians. Maintaining good daily energy intake (≥2035 kcal), however, was strongly and independently protective against developing depression. Diet was measured rigorously using three 24h recalls for each participant, and analyses were controlled for several important potential confounders.

The observed lack of association between dietary patterns and late-life depression incidence could have a number of explanations. Dietary patterns may not play a role due to insufficient variation in diet in this population. Small variations in patterns of food consumption among older individuals were also observed by other similar studies (21, 31). The quality of the diet appears to be less important than consuming sufficient energy and nutrients contained in these foods.

Our findings corroborate with those from the Nurses' Health Study in the US (31). Among the 50,605 female nurses (50–77 y) free of depression at baseline followed for over 12 y, no significant longitudinal associations between incident depression and either "Prudent" or "Western" dietary patterns after controlling for social, health, and dietary confounders were observed (31). It seems the association of healthy diets (i.e. high in fruits, vegetables, and whole-grains) with lower risk of depression is not clear even among middle-aged adults. In UK, (17) a "whole food" pattern, obtained through factor analysis, was not protective of depression five years later once participants depressed at baseline were excluded. Le Port et al. (18) followed 12,404 public sector employees in France aged 45 to 60 for 10 years and, also using factor analysis to identify dietary patterns, observed that the "healthy diet" pattern was not protective in either men or women who were not initially depressed. In the Australian Longitudinal Study on Women's Health (n=7,588, 50-55y), six dietary patterns were identified through factor analysis. Two, the "Mediterranean-like" and "fruit" dietary patterns, were associated with lower risks of depression three years later when adjusting for confounders, but the latter became just marginally associated (p=0.03) after further adjustment for baseline depressive symptoms (19). In contrast, among 8,660 generally healthy men and women born in Australia, aged 50–69 years and followed for 12 years, the "Australian Dietary Pattern," but not the "Mediterranean Dietary Pattern," was protective for depression risk after controlling for several confounders (32). The study did not explore depression incidence, however, as baseline depressive symptoms were not available and, hence, not controlled.

Longitudinal evidence to date suggests that dietary patterns may not be a strong predictor of incident depression. The potential association of depression with dietary patterns may be due to existing depression history, which predicts the subsequent depression (33). Moreover, with respect to late-life depression, although protecting against dietary deficiencies and excesses is important, the intake of certain food items may not be more protective than just an adequate overall intake. Among participants of the Chicago Health and Aging Project, for instance, researchers reported an energy intake of 1,500 ± 573 kcal in the lowest tertile of Mediterranean Diet Score (MedDietScore) and 1,945 ± 578 kcal in the upper tertile, which had lower annual depression rates (34). A 3-month clinical trial testing the effects of fasting and moderate calorie restriction in 32 healthy Malay men, aged 50 to 70 years, found no significant differences in depression scores (35). The higher overall energy intakes in our study may reflect a higher energy expenditure, possibly due to higher physical activity potentially due to better health (36, 37). Higher activity levels are associated with better overall health and lower risk for several diseases including depression (38, 39). In NuAge, those in the highest tertiles of "varied" and "traditional" diets had indeed a higher PASE score, and, as in other studies (4, 40, 41), lower functional autonomy was associated with depression. Thus, good overall intake may also reflect better physical capacity. Energy intake was, however, a strong predictor of depression independently of functional limitations and physical activity. Persistent low energy intakes can lead to malnutrition, which is associated with elevated depression risk (42). It is possible that, while aging, eating patterns somewhat lose their importance as compared to other biological, psychosocial, or health factors. Alexopoulos (33) contends that depressive symptoms in the elderly are more likely to be caused by serious diseases, including cancer, cerebrovascular disease, chronic medical illness, disease complications, cognitive impairment and disability.

In conclusion, dietary patterns were not associated with a 3-y depression incidence in healthy, community-dwelling older adults. Continuing to eat a sufficient quantity may be more protective than small variations in quality, independent of other health indicators such as physical activity and functional autonomy.

Ethical Standards: This study complies with the current Canadian laws. Ethics was approved by the Geriatric University Institutes of Montréal and Sherbrooke, and by the Research Ethics Board from McGill University. The research protocol for NuAge has been approved by the ethics committees of both the Geriatric University Institutes of Montreal and Sherbrooke. The protocol for this study has been approved by the Faculty of Agricultural and Environmental Sciences Research Ethics Board from McGill University. All participants signed the consent form, after being fully informed of the study objectives and procedures and of their right to withdraw from the study at any time. The consent form includes also an authorization to be contacted for subsequent studies and to provide medical information to participant's family physician when subsequent follow-up, clinical investigation, or health care are required.

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