



Severe Psychopathology and Substance Use Disorder Modify the Association Between Housing Trajectories and Food Security Among Homeless Adults

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Purpose: We examined the housing trajectories of homeless people with mental illness over a follow-up period of 6 years and the association of these trajectories with food security. We then examined the modifying role of psychopathology and alcohol and substance use disorders in this association.

Materials and Methods: We followed 487 homeless adults with mental illness at the Toronto site of the At Home/Chez-Soi project—a randomized trial of Housing First. Food security data were collected seven times during the follow-up period. Psychopathology (Colorado Symptom Index score) and alcohol and substance use disorders were assessed at baseline. Housing trajectories were identified using group-based trajectory modeling. Logistic regression was used to estimate the association between housing trajectory groups and food security.

Results: Three housing trajectory groups were identified: rapid move to consistent stable housing (34.7%), slow and inconsistent housing (52.1%), and never moved to stable housing (13.2%). Individuals included in the rapid move to consistent housing trajectory group had higher odds of remaining food secure compared with those in the never moved to stable housing trajectory group over the follow-up period [AOR 2.9, 95% CI: 1.3–6.6, *P*-value: 0.009]. However, when interactions were considered, this association was significant among those with moderate psychopathology but not severe psychopathology. Individuals with substance use disorder and in the never moved to stable housing group had the lowest food security status.

Discussion: Severe psychopathology and substance use disorders modified the association between housing trajectories and food security. International Standard Randomized Control Trial Number Register (ISRCTN42520374).

Keywords: psychopathology, substance use disorder, housing trajectories, food security, homeless adults

INTRODUCTION

Homelessness (living without stable, safe, permanent, appropriate housing or the immediate prospect, means and ability of acquiring it (1) is detrimental for almost every life dimension of affected individuals. Being homeless is a crucial stress factor for well-being as it reflects severe material deprivation and, in addition, erodes mental, cognitive, and physical health (2–8); exposes individuals to risky conditions and behaviors [e.g., violence, bad meteorological conditions, discrimination; (9, 10)]; and precludes access to such basic services as sanitation, healthcare, water, or food (11–13).

Access to food is a consistent unmet need of homeless populations. Compared with the general population, homeless individuals have lower food security (14), lower nutrient intake, and diet insufficiency (15, 16). Homeless individuals typically cannot access kitchens to prepare meals and preserve perishable foods (17, 18), forcing them to depend on fast food, shelter or community meals, and even food waste to meet their needs or to remain hungry (19–21). The intertwining of homelessness with mental illness and substance use worsens access to food because it generates competing needs for purchasing medications and substances (22–25).

Housing First (HF) interventions—generally including rent supplements and mental health support services—have been implemented internationally to facilitate exit from homelessness to stable housing while also providing social and health services to support housing stability and enhance health and well-being (26, 27). Studies in Canada and the United States demonstrate the effectiveness of HF interventions in promoting rapid exit from homelessness (28–30). However, two main concerns have been raised about these interventions. First, exiting homelessness remains a complex and non-linear process (31–33). Although some individuals who participate in HF interventions move rapidly and remain stably housed, others are either less successful in remaining stably housed or are never able to become stably housed (31, 32). These different housing trajectories affect and reflect other aspects of the lives of homeless adults. A study by Kerman et al. finds that housing trajectories shape patterns of social services use, independent of whether individuals are in the intervention or standard treatment arms (34). For example, participants who achieved sustained housing stability across both intervention and standard treatment groups have similar patterns of emergency department use, hospitalization, inpatient psychiatric admission, or food bank use. Within the intervention group, social and health services use was largely different among subgroups of individuals with different housing patterns.

Second, as for several mental health outcomes, HF interventions seem to have limited effect on quality of life of homeless individuals, including the satisfaction of some basic needs, such as food security, which is at the physiological level of Maslow's pyramid of needs and well-being (35–37). Previous analysis of HF in five Canadian cities over a 2-year period showed that access to stable housing was not sufficient to improve food security among individuals with mental illness (37). However, the heterogeneity of housing trajectories was not adequately accounted for in that study.

Here, we examine patterns of exiting homelessness to stable housing (housing trajectory groups) among homeless individuals with mental illness participating in the Toronto At Home/Chez Soi Study over a follow-up period of 6 years (38). This long follow-up period provided enough time to observe consistent changes over time, contrary to previous analyses that were limited to 2 years (31, 33, 39). Second, we ask whether these housing trajectory groups were associated with food security of study participants over the study period. Finally, we investigated whether the association between housing trajectory groups and food security differed across the severity of psychopathology and alcohol and substance use disorders. We hypothesized that a rapid move to stable housing was associated with consistent food security over the follow-up period and that this association was weaker among participants with severe psychopathology and alcohol and substance use disorders.

MATERIALS AND METHODS

AH/CS Intervention

This study used data from the Toronto site of the At Home/Chez Soi (AH/CS) study, which was a randomized trial that compared the HF intervention (provision of mental health support services, such as assertive community treatment or intensive case management, plus rent supplement) to treatment as usual (TAU) (access to social, housing, and health services available in the community) (40). Participants were recruited from Toronto community agencies, shelters, clinics, and directly from the street between October 2009 and July 2011. The Toronto AH/CS participants were initially followed for 2 years (Phase I) between October 2009 and July 2013. In 2013, the study received additional funding to extend its follow-up period from January 2014 to March 2017 (Phase II) for a total follow-up period of approximately 6 years. Detailed information on study recruitment, design, population, and measurement instruments is reported elsewhere (41).

Four inclusion criteria were used to select AH/CS study participants: (1) being 18 years of age or older, (2) being absolutely homeless or precariously housed, (3) having a diagnosed severe mental disorder, and (4) not being served by assertive community treatment or an intensive case management program. Prior to randomization, participants were stratified by their level of needs for mental health services as high needs (HN) and moderate needs (MN). The level of need for mental health services was assessed using a combined algorithm that included having a psychotic disorder or bipolar affective disorder with psychotic symptoms [based on the Mini International Neuropsychiatric Interview 6.0 (MINI)], low community functioning [based on the Multnomah Community Ability Scale (MCAS)], presence of a comorbid substance use disorder, and prior history of hospitalizations and incarcerations (40–43). Out of the 575 Toronto participants, 197 participants met criteria to be classified as HN and 378 as MN. Then, according to their level of need, participants were randomly assigned to either the HF treatment or TAU. Participants assigned to the treatment group with HN received HF support services with assertive community treatment (ACT), and those

with MN received HF support services with intensive case management (ICM) treatment. Participants assigned to the TAU group continued to have access to housing and social and health support services locally available in their communities.

Ethical considerations

The Toronto AH/CS study received approval from the St. Michael's Hospital Research Ethics Board (Canada), and all participants gave informed written consent to participate in the AH/CS study. The AH/CS study is also registered with the International Standard Randomized Control Trial Number Register (ISRCTN42520374).

Measures and Operational Definitions

Stable Housing

We captured stable housing through a residential timeline follow-back calendar (RTLFB) questionnaire (31, 44), which was administered every 3 months (Phase I) or 6 months (Phase II) to track the number of days living/sleeping in different types of housing accommodations. An accommodation was defined to be stable housing if the participant had tenancy rights or was expected to remain in the same accommodation for more than 6 months. For each follow-up year, participants were classified as being stably housed if they remained in stable housing for at least 75% of RTLFB-accounted days over a calendar year.

Consistent Food Security

The modified version of the U.S. Adult Food Security Survey Module (US FSSM) [U.S. Department of Agriculture, Economic Service Research (45) U.S. Adult Food Security Survey Module: Three-Stage Design, with Screeners, 2012] was used to assess the food security status of each participant over the 30 days prior to interview time points. Data were gathered every 6 months during phase I and every 12 months during phase II up to seven times across the 6-year follow-up period. This instrument has been validated in previous studies to assess food security for individuals experiencing homelessness (46–48). It contains 10 items related to food access, and the code responses were summed up to compute the food security score. This score ranges from 0 to 10 and classifies food security status into two main groups: food secure [those with high food security (score = 0) and marginal food security (score = 1–2)] and food insecure [those with low food security (score = 3–5), and very low food security (score = 6–10)] (37, 49, 50).

Participants were classified as being consistently food secure over the follow-up time if they were in the “food secure” group for more than 50% of the duration of their follow-up interviews. For example, a participant with four follow-up interviews had to be food secure at least three times (more than 50%) to be classified as consistently food secure. To ensure that participants had a minimum follow-up number of interviews for the analysis, we excluded those who had fewer than three food security interviews ($n = 88$).

Covariates

HF Intervention

Because the present study is embedded within an HF intervention, we considered the indicator of HF treatment (HF vs. TAU) as a covariate to adjust for the housing trajectory groups over the follow-up period.

Other covariates included sociodemographic variables (age at baseline (in years), self-reported gender (classified as male or not male), ethno-racial group membership [ethno-racial and not ethno-racial group], and marital status (single or not)), number of children under 18 years, and lifetime duration of homelessness prior to study enrolment (<3 and ≥ 3 years). No other gender categories were considered because there were fewer than 10 non-binary individuals in our sample. Participants were asked whether they used a food bank in the last 6 months prior to food security interviews, and we counted the number of times over the follow-up period.

Modifier Variables

Severe psychopathology

We used the Colorado Symptom Index score (CSI) at baseline to assess for the effect of psychopathology on food security (40, 51). CSI is a widely used self-report measure of psychiatric symptomatology and includes 14 items. Participants were asked how often they experienced specific psychiatric symptoms, such as “How often have you felt nervous, tense, worried, frustrated, or afraid?” or “How often have your voices, thoughts, or feelings interfered with your doing things?” Their responses were graded using a five-point Likert-items rated from “not at all” (1) to “at least every day” (5). Total scores ranged from 14 to 70, and higher scores indicated more severe psychiatric symptoms. Previous studies show that this index has high internal consistency (Cronbach's alpha = 0.92) (52, 53). CSI was dichotomized using a preestablished clinical threshold 30 or higher to indicate individuals with high (1) or low (0) psychopathology severity (52).

Alcohol and Substance disorders

Alcohol and non-alcohol substance use disorders were identified separately based on DSM-IV criteria using the MINI 6.0 and were evaluated at the time participants were screened for entering the study (40, 54).

Statistical Methods

We used group-based trajectory modeling to identify patterns of exiting homelessness to stable housing over the 6-year follow-up period (55). This modeling technique allows for the identification of clusters of individuals who followed a similar housing trajectory over time (56). Assuming a logistic distribution of housing stability, it uses intercept and time as change parameters to estimate latent trajectory groups. For the shape of trajectory groups, we tested different polynomial growth factors (linear, quadratic, and cubic time factors) and determined the optimal number of trajectory groups through the Bayesian information criterion (BIC). To determine the best-fit trajectory shapes, we used the average posterior probability measure and the weighted odds of correct classification (OCC) (55). Afterward, the model

TABLE 1 | Characteristics of the At Home/Chez Soi participants at baseline ($n = 487$).

Variable	<i>n</i>	%
Consistently food secure		
Yes	194	39.8
No	293	60.2
Gender		
Male	333	68.4
Female	154	31.6
Age group		
18–34	172	35.3
35–44	127	26.1
45–74	188	38.6
Education level		
Middle/high school	228	48.1
Completed high school	85	17.9
Graduate/post-graduate	161	34.0
Ethno-racial group membership		
Ethno-racial	282	57.9
not ethno-racial	205	42.1
Marital status		
Not married	327	67.1
Married	160	32.9
Lifetime duration of homelessness		
<3 years	210	44.97
3 years or more	257	55.03
Number of children under 18 [Mean (SD)]	487	1.6 (1.1)
Food bank use [Mean (SD)]	487	1.97 (1.96)
Intervention		
Housing First (HF)	272	55.9
Treatment as usual (TAU)	215	44.1
Severe psychopathology (CSI* ≥ 30)	378	77.6
Alcohol use disorder	214	43.9
Substance use disorder	231	47.4

*Colorado symptoms index—SD, standard deviation.

was adjusted for HF intervention group membership. All models were estimated using the module *Traj* in Stata 15 (55).

Next, we used logistic regression models to estimate odds ratios and 95% confidence intervals for the association between housing trajectory groups and consistent food security over the 6-year follow-up period. Then, we adjusted the model including the following covariates: age, self-reported gender, ethno-racial group membership, marital status, number of children under 18 years, lifetime duration of homelessness, food bank use, severe psychopathology, alcohol use disorder, and substance use disorder. To assess the modifying effect of severe psychopathology and alcohol and substance use disorders, we reestimated the model with interaction terms, and the interaction graphs are presented. All statistical analyses were performed with Stata version 15 (StataCorp. 2017. Stata Statistical Software: Release 15. College Station, TX: StataCorp LLC.).

RESULTS

Sample characteristics are summarized in **Table 1**. Of 487 participants, 39.8% were consistently food secure (with high or marginal food security status) over the study period. Severe psychopathology was present in 77.6%, and 43.9 and 47.4% had alcohol and substance use disorders, respectively.

Housing Trajectories

Three housing trajectory groups were identified: a rapid move to consistent stable housing trajectory with a quadratic form, a slow and inconsistent housing trajectory with a cubic form, and a never moved to stable housing trajectory (see **Table 2** and **Figure 1**). Of the 487 participants, 34.7% of participants were classified in the rapid move to consistent stable housing group and 52.1% in the slow and inconsistent housing group; 13.2% never moved to stable housing during the study period. The BIC fit statistics confirmed this model as the best fit model (BIC for the two-group model = -1416.08 ; BIC₃ = -1400.10 , and BIC₄ = -1455.53). The average posterior probability (>0.70) and the OCC-weighted posterior portability (>5) also indicate good fit. The adjusted model demonstrates that the HF intervention influences the trajectories, mainly by increasing the probability of having a rapid move to consistent housing and decreasing the probability of never moving or slow compared with the slow and inconsistent housing trajectory. Average posterior probabilities and two of the OCC-weighted posterior probabilities indicate improvement after the adjustment.

Housing Trajectory and Consistent Food Security

Compared with those in the never moved to stable housing trajectory, those in the rapid move to consistent housing stability group were more likely to be consistently food secure, AOR 2.9 [95% CI (1.3–6.6)] (see **Table 3**). Likewise, those with severe psychopathology and a substance use disorder were less likely to be consistently food secure (AOR 0.39 [95% CI (0.24–0.63)]) and 41% (AOR 0.59 [95% CI (0.37–0.95)]), respectively.

Modification Effects of Psychopathology and Substance Use Disorder

As shown in **Figure 2**, among participants with low psychopathology, those who moved to housing (rapid move to consistent housing and slow and inconsistent housing) were 40% more likely to be consistently food secure compared with those who never moved to stable housing. Conversely, among participants with severe psychopathology, no difference is observed between the housing trajectory groups. Likewise, those with no alcohol or substance use disorders and who never moved to stable housing were least likely to be consistently food secure (**Figure 3**). No modification effect was observed for alcohol use disorder.

DISCUSSION

This study examined housing trajectories and their association with food security among homeless adults with mental illness

TABLE 2 | Housing Trajectory Groups adjusted from Group-Based Trajectory modeling.

Parameters	Model I				Model adjusted for intervention group					
	Intercept	Linear	Quadratic	Cubic	Intercept	Linear	Quadratic	Cubic	AH	P-value
Rapid to consistent housing	-12.2	16.4	-2.3		-14.9	20.9	-3.0		2.1	0.001
Slow and inconsistent housing	-3.5	3.2	-0.8	0.1	-3.7	3.4	-0.9	0.1	Ref.	
Never moved to stable housing	-3.0				-2.9				-1.2	0.017
BIC	-1400.1				-1353.6					

Group	N (%)	Group APP	OCC weighted	N (%)	Group APP	OCC weighted
Membership and posterior probability						
Rapid to consistent housing	206 (38.4)	0.88	11.29	186 (34.7)	0.92	22.64
Slow and inconsistent housing	264 (49.2)	0.86	6.54	279 (52.1)	0.86	5.69
Never moved to stable housing	66 (12.4)	0.83	34.16	71 (13.2)	0.86	39.22

APP, average of the maximum posterior probability of assignments. OCC, Odds of correct classification weighted posterior probability. Bold: significant at a level of 5%.

in a large urban center. Three housing trajectory groups were identified: a rapid move to consistent housing group, a slow and inconsistent housing group, and a never moved to stable housing group. These results corroborate findings from previous studies on the complexity of exiting homelessness. Adair et al., using data from the multisite at Home/Chez Soi study of HF, found different housing trajectories over a 2-year period, including a group of almost no time housed (29%); a group of rapid and sustained housing (33%); and several small groups, such as slow and sustained housing, early housing, and gradually lost, rapid gain, and steep decline (31). Another study among homeless youth in Los Angeles County identified three trajectories over a 2-year period, a consistently sheltered group, a group with a high probability of finding and maintaining shelter over time, and a last group who remained inconsistently sheltered over a long term (33). Contrary to these studies conducted over a period up to 2 years, our study looked at pathways out of homelessness to housing over a period of 6 years.

Our results indicate that providing housing is only one step toward supporting people experiencing homelessness by helping them leave streets and shelters and entering a residence. However, even after achieving housing, these individuals face several personal, economic, and social challenges and extreme poverty that can impede their achievement of long-term housing stability (32, 57–59). Moving into stable housing is accompanied by additional living costs (e.g., paying for utilities) that compete with other basic needs (e.g., food), rendering individuals vulnerable to eviction and repeated homelessness.

Our results also show that individuals in the rapid move to consistent housing group were more likely to be food secure compared with those in the never moved to stable housing group over the follow-up period. However, this association disappeared for those with severe psychopathology. Furthermore, those with

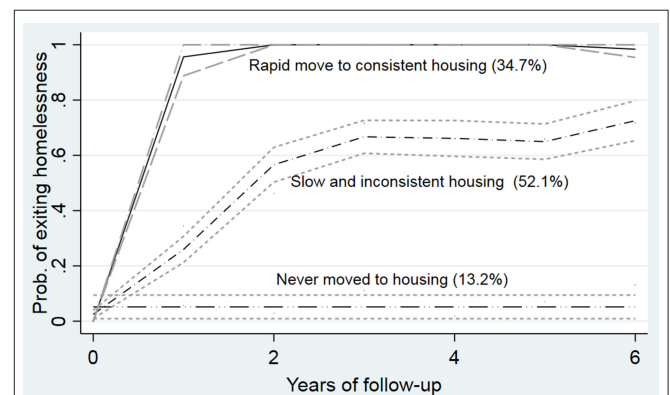


FIGURE 1 | Housing trajectory groups over time points with 95% confidence interval.

substance use disorders and in the never moved to stable housing group were least likely to be food secure. Our results support findings from a recent study conducted by O'Campo et al. (37) on the role of housing stability as a key determinant of food security. Our findings offer new insight into the complexity of how pathways out of homelessness interact with mental health and substance use disorders to prevent individuals from achieving food security. The combination of a difficult housing trajectory with mental illness might prevent employment, forcing individuals to make trade-offs between food security, stable housing (e.g., rent), and other basic needs (59–61).

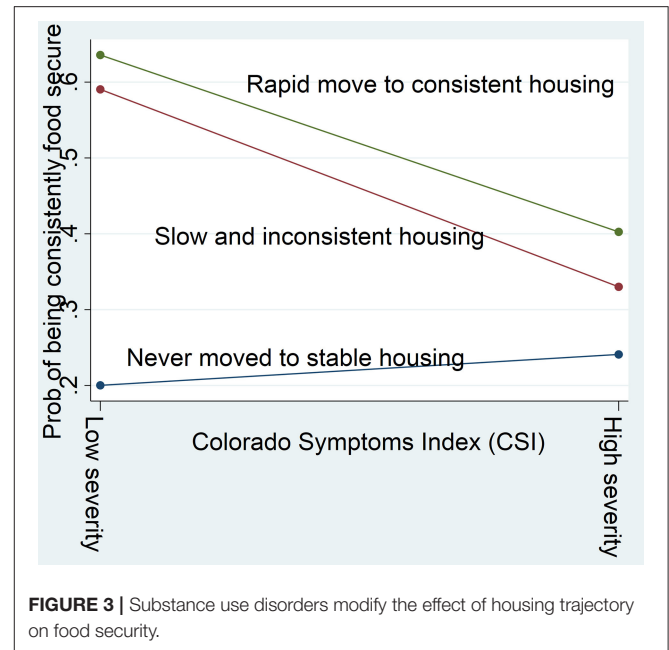
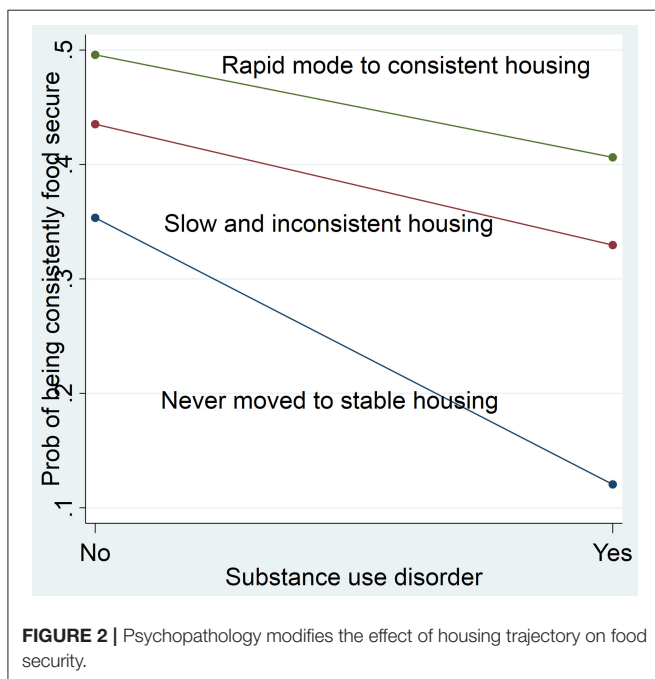
There are several study limitations to note. First, food security data may be affected by recall bias, which might influence the accuracy of reported findings. Second, there were not enough follow-up interviews to consistently assess food security over the

TABLE 3 | Multivariable logistic regressions for consistent food security and housing trajectory groups adjusted for baseline characteristics.

Variable	AOR (95% CI)	P-value
Housing Trajectory groups		
Never moved to stable housing (ref.)		
Slow and inconsistent housing	2.2 (1.0–4.8)	0.053
Rapid and stable housing	2.9 (1.3–6.6)	0.009
Severe psychopathology	0.39 (0.24–0.63)	0.001
Alcohol use disorder	1.01 (0.63–1.61)	0.964
Substance use disorder	0.59 (0.37–0.95)	0.031
Intercept	1.24 (0.40–3.90)	0.709

AOR, adjusted odd ratios.

The model is adjusted for the following variables: Gender, age, education level, ethno-racial group, marital status, lifetime homelessness, number of children under 18, and food bank use. Bold: significant at a level of 5%.



entire study period. More food security interviews over the same follow-up period would have required reducing the time interval between interviews. Finally, this study focuses on homeless adults who have mental illness and is also limited to an only site, Toronto City, and cannot be generalized to all homeless adults.

Notwithstanding these limitations, this study provides a comprehensive view of the complexity of exiting homelessness to stable housing and its influence on food security. The analysis also offers insight into how psychopathology and substance use disorders contribute to poor food security even after homeless people achieve long-term housing stability. This study has two main policy implications. First, housing interventions must focus on achieving housing stability over a long period of time with special attention on factors that increase risk for unsuccessful housing trajectories. Second,

it is important to enhance housing interventions with food security programs to better address the food needs of homeless adults with severe psychopathology and substance use disorders.

DATA AVAILABILITY STATEMENT

Data cannot be made publicly available for both ethical and legal reasons. They were collected from randomized trial implemented within a hospital setting, St. Michael’s Hospital in Toronto, which conferred the participants the status of patient. Data also contain information related to mental health status of the participants. Data collection, use, and disclosure are governed by the Personal Health Information Protection Act (PHIPA, 2004) and must not be disclosed without their written informed consent, as was stated in the written informed consent form by law. As the study addresses a specific and small subpopulation, any combination of three to four variables can facilitate the identification of some participants. Nonetheless, Home/Chez Soi Toronto Data will be available to investigators for studies that have received approval from research ethics boards. Study proposals and data access requests should be sent to Evie Gogosis at evie.gogosis@unityhealth.to.

ETHICS STATEMENT

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the Research Ethics Board of St. Michael’s Hospital (Canada). Written informed consent was obtained from all subjects/patients. The At Home/Chez-Soi study is registered with the International Standard Randomized Control Trial

Number Register (ISRCTN42520374). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

JL, CM-L, and PO'C conceived and designed the present research study. JL conducted the final statistical analysis, interpreted the data, and wrote the first manuscript draft. CM-L, RW, RN, and ML assisted in the study design, interpretation of the results, and revision of the first manuscript draft. PO'C, VS, and SH were also the principal investigators of the AH/CS study, Toronto site. All the co-authors revised and approved the present final manuscript version. All authors contributed to the interpretation of the results and critical revision and edition of the final manuscript.

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