Economic impacts and cost-effectiveness of Housing First interventions for people experiencing homelessness

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Abstract

Background. Housing First (HF) provides rent supplements and supports to help homeless individuals with mental illness obtain stable housing. A 2015 literature review reported that HF was associated with cost offsets, however, they tended to be less than the cost of the intervention. Since then, additional studies, including the finalized cost-effectiveness analyses of the At Home/Chez Soi (AHCS) trial, have been published.

AHCS recruited participants in 5 Canadian cities from October 2009 to June 2011 and followed them for up to 24 months. At baseline, participants were classified as high-needs (HN) or moderate-needs (MN). HN participants were randomized to receive either HF with Assertive Community Treatment (ACT) or Treatment as Usual (TAU), while MN participants were randomized to receive either HF with Intensive Case Management (ICM) or TAU, until at least March 2013. In Montreal, HF services were reduced after March 2013. Participants' use of services over 6 months 4 years after baseline was collected between February 2014 and March 2015.

Objectives. The goals of this thesis were to (1) provide an updated review of the economic impacts of HF and (2) evaluate the cost-effectiveness of HF in Montreal 48 months post-baseline.

Methods. (1) A systematic review was performed on MEDLINE, Google, and the Homeless Hub repository, from January 2007 to December 2022. Study characteristics and results were extracted from selected studies; (2) Effectiveness was measured using the number of days of stable housing and days in one's own apartment. The cost-effectiveness of HF with ACT compared to TAU and HF with ICM compared to TAU were evaluated.

Results. (1) Twenty-one studies were retained. Shelter, emergency department, and inpatient costs decreased with HF, while impacts on other health and justice costs were inconsistent. Among studies that reported the cost of the intervention, 2 of the 3 pre–post studies reported a decrease in net costs with HF. The 3 quasi-experimental studies with a comparison group reported an increase in net costs. Four of 5 experimental studies reported an increase in net costs, while one, conducted in France, reported cost offsets equal to the cost of the intervention. Two modeling studies projected that HF would be associated with decreased or marginally higher net costs over 10- and 35-year horizons.

(2) 362 participants were included. At 43-48 months, in the HF with ACT group, 34.6% of participants received rent supplements, 7.1% received ACT, and 25.6% received both services. Corresponding percentages for the HF with ICM group were all 17.7%. The average cost for the HF with ACT group (\$71,859 (95% CI: \$52,300, \$83,900)) was higher than for the TAU group (\$67,448 (\$45,000, 84,900)), and effectiveness was similar (200 (155, 237) vs 195 (151, 240)) when using days of stable housing. The average cost was slightly lower for the HF with ICM group than for TAU (\$42,894 (\$32,900, \$44,600) vs \$44,301 (\$33,400, \$48,800)) while effectiveness was greater (274 (253, 293) vs 225 (190, 257)). Effectiveness measured as days in an apartment was greater for the HF group for both need levels. The incremental cost-effectiveness ratio (ICER) was \$873 per day of stable housing (undefined, \$3,150) for HF with ACT, while HF with ICM was dominant (undefined, \$356). When the measure of effectiveness was changed to days in an apartment, the ICER was \$54 per day in an apartment (undefined, \$2,842) for HF with ACT, while HF with ICM remained dominant (undefined, \$71). At up to \$250 per day of stable housing, HF with ACT had a 40% chance of being cost-effective, vs 96% for HF with ICM.

Conclusion. The updated literature review, like the previous one, suggests that over a 2-year horizon, HF leads to significant cost offsets that are usually less than but may equal the intervention cost. The results appear to vary according to context. The results of the cost-effectiveness analysis suggest that HF can be cost saving and remain more effective following a reduction of services at 43-48 months for MN participants. A greater proportion of HN participants may require continuance of HF for the intervention to remain cost-effective.

Résumé

Contexte. Le logement d'abord (LA) est une intervention qui fournit des suppléments de loyer et un soutien aux personnes sans domicile et souffrant de maladie mentale. Une analyse documentaire réalisée en 2015 a montré que le LA était associé à des compensations de coûts, mais que cellesci étaient généralement inférieures au coût de l'intervention. Aucune mise à jour n'a été effectuée depuis, malgré la publication de plusieurs études, y compris les résultats définitifs de l'étude At Home/Chez Soi (AHCS).

L'étude AHCS a recruté des participants dans cinq villes canadiennes entre octobre 2009 et juin 2011 et les a suivis pendant 21 à 24 mois. Au départ, les participants ont été classés comme ayant des besoins élevés (BÉ) ou modérés (BM). Les participants BÉ ont été randomisés pour recevoir soit le LA avec suivi intensif (SI) ou soit les services habituels (SH) tandis que les participants à besoins modérés (BM) ont été répartis au hasard pour recevoir soit LA avec soutien d'intensité variable (SIV), soit SH, jusqu'à au moins mars 2013. À Montréal, les services LA ont été réduits après mars 2013. L'utilisation de services des participants durant les 6 mois précédant 4 ans après l'entrée dans l'étude ont été collectés entre février 2014 et octobre 2015.

Objectifs. Les objectifs de cette thèse étaient de (1) mettre à jour la littérature sur les impacts économiques de LA et (2) d'évaluer le rapport coût-efficacité de LA à Montréal 48 mois après la date de référence.

Approche. (1) Nous avons effectué une revue systématique à partir de MEDLINE, Google et du Rond-point de l'itinérance, de janvier 2007 à décembre 2022. Les données extraites comprenaient la conception de l'étude, la perspective économique, la taille de l'échantillon, la population, la durée, l'utilisation des services, la compensation des coûts et la nature de l'intervention; (2) L'efficacité a été mesurée en fonction du nombre de jours de logement stable et du nombre de jours passés dans son propre appartement. Le rapport coût-efficacité de LA avec SI par rapport à SH et de LA avec SIV par rapport à SH a été évalué.

Résultats. (1) L'étude a sélectionné vingt-et-un articles. Les coûts liés à l'hébergement, aux services d'urgence et à l'hospitalisation ont diminué avec LA, tandis que les impacts sur les autres coûts de santé et de justice n'étaient pas uniformes. Parmi les études qui ont rapporté le coût de l'intervention, 2 des 3 études pré-post ont relevé une nette diminution des coûts totaux liés à LA.

Trois études quasi-expérimentales avec un groupe de comparaison ont relevé une augmentation nette des coûts totaux. Quatre des cinq études expérimentales ont relevé une augmentation nette des coûts totaux, tandis que l'une d'entre elles, réalisée en France, a relevé une compensation des coûts égale au coût de l'intervention. Les études de modélisation prévoient que l'HF serait associée à une diminution ou à une augmentation marginale des coûts nets sur des horizons de 10 et 35 ans; (2) 362 participants ont été inclus. À 43-48 mois, dans le groupe LA avec SI, 34,6 % des participants ont reçu des suppléments au loyer, 7,1 % ont reçu le SI et 25,6 % ont reçu les deux services. Les pourcentages correspondants pour le groupe LA avec SIV étaient tous de 17,7%. Le coût moyen pour le groupe LA avec SI (71 859 \$ (intervalle de confiance à 95% : 52 300 \$, 83 900 \$)) était plus élevé que le groupe SH (67 448 \$ (45 000 \$, 84 900 \$)) et l'efficacité était similaire (200 (155, 237) vs 195 (151, 240)) lorsque l'on utilise les jours de logement stable pour les participants BÉ. Cependant, pour les participants BM, le coût moyen était inférieur pour le groupe LA avec SIV que pour le groupe SH (42 894 \$ (32 900 \$, 44 600 \$) vs 44 301 \$ (33 400 \$, 48,800 \$)) alors que l'efficacité était plus grande (274 (253, 293) vs 225 (190, 257)). L'efficacité mesurée en nombre de jours dans un appartement était supérieure pour le groupe LA pour les deux niveaux de besoins. Le rapport coût-efficacité différentiel (RCED) était de 873 \$ (indéfini, 3 150 \$) par jour de logement stable pour le LA avec SI, tandis que le LA avec SIV était dominant (indéfini, 356 \$). Lorsque la mesure de l'efficacité a été changée pour les jours en appartement, le RCED était de 54 \$ (indéfini, 2 842 \$) par jour en appartement pour le groupe LA avec SI, tandis que le LA avec SIV était toujours dominant (indéfini, 71 \$). À 250 dollars par jour de logement stable, le rapport coût-efficacité du programme LA avec SI avait 40% de chances d'être coûtefficace, contre 96 % pour LA avec SIV.

Conclusion. La revue de la littérature actualisée, tout comme la précédente, suggère que sur un horizon de deux ans, LA conduit à des compensations de coûts significatives qui sont généralement inférieures au coût de l'intervention, mais qui peuvent être égales à celui-ci. Les résultats semblent varier en fonction du contexte. Les résultats de l'analyse coût-efficacité suggèrent que LA peut réduire les coûts totaux et rester plus efficace après une réduction des services à 43-48 mois pour les participants BM. Une plus grande proportion de participants BÉ peut nécessiter la poursuite de LA pour que l'intervention reste coût-efficace.

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Contributions of Authors

Charlene Weight drafted all sections of the thesis. Dr. Eric Latimer conceived the thesis topics and acquired the data for the cost-effectiveness analysis. He also collaborated closely on the manuscript concerning the economic impacts of Housing First. Charlene Weight analysed the data for the cost-effectiveness analysis with support from Drs Eric Latimer and Erica Moodie. Charlene Weight and Drs Eric Latimer, Erica Moodie, and Dimitra Panagiotoglou contributed to the interpretation of the data, critically revised the thesis and the manuscript, and approved the final version.

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List of Abbreviations/Acronyms

ACT: Assertive Community Treatment AHCS: At Home/Chez Soi CEAC: Cost-Effectiveness Acceptability Curve **ED: Emergency Department** HF: Housing First HN: High needs HSJSU: Health, social, and justice service use questionnaire ICER: Incremental cost-effectiveness ratio ICM: Intensive Case Management MN: Moderate needs PEH: People experiencing homelessness **RCT: Randomized Control Trial** RTLFB: Residential Timeline Follow-back questionnaire TAU: Treatment as Usual VTLFB: Vocational Timeline Follow-back questionnaire

1. Introduction

In 2016, an estimated 235,000 people experienced homelessness in Canada (1). Since then, pointin-time counts conducted across Canada in a consistent manner suggest that the problem has grown considerably in magnitude (2, 3). Homelessness is, in part, a public health concern due to its association with a range of negative physical and mental health outcomes and an increased risk of mortality (4). People experiencing homelessness (PEH) face difficulties accessing the health care system and tend to have more unaddressed health needs compared to the general population (5). PEH have difficulties acquiring and retaining employment and approximately 75% of PEH income comes from welfare or disability benefits (6). PEH also tend to have more involvement with the justice system compared to the general public (7, 8). PEH use health, social, and justice services frequently; it has been estimated that PEH who have mental illness cost approximately \$60,000 in healthcare, social and justice services per person per year in Canada's three largest cities, Montreal, Toronto, and Vancouver (9). Therefore, homelessness is both a public health and economic concern that needs to be addressed.

Canada has implemented multiple policies to reduce the number of PEH, although these policies have been unable to reduce this number (10-12). In contrast, Finland has implemented multiple policies to address homelessness (13) and in 2008, implemented Housing First (HF) on a national scale to reduce the number of people experiencing long-term homelessness (14).

HF is an intervention to help PEH with mental illness obtain and retain stable housing. HF provides rent subsidized apartments for which participants pay 25-30% of their income and receive support through case management (15). This intervention differs from traditional approaches to homelessness by housing people regardless of apparent housing readiness, and in particular regardless of whether substance abuse is ongoing (15, 16). HF has been associated with outcomes such as improved days of stable housing and quality of life for participants (17, 18). Further, studies have shown that HF can generate cost offsets due to reduction in use of services such as emergency department (ED) visits and emergency shelters (19). HF, in some cases, can be cost-effective compared to traditional homeless services for PEH (20, 21). However, few studies have examined if HF is cost-effective for longer than 2 years, except using a modeling approach. Further, no study has determined if the intervention remains cost-effective after reducing HF services after 2 years and if the reducing services will impact health, social, and justice costs among PEH.

This thesis had two objectives: (1) to systematically review the economic impacts of HF and (2) determine the cost-effectiveness of HF compared to TAU at 48 months post-randomization. The thesis is by Manuscript, with the first aim written in this format and found in Chapter 3. Chapters 4-5 detail the methods and results of the second aim; this will ultimately be formatted into a second manuscript.

To address the first objective, a previous literature review published in 2015 was updated. That review found that pre-post studies show HF as cost saving, but suggested that this could be due to regression to the mean: quasi-experimental studies with a comparison group were equivocal, while experimental studies tended to show cost offsets less than the cost of the intervention (19). The search strategy used the same keywords as the original review which included "Housing First", "Cost-effectiveness", "Cost-analysis", "Cost", "Economic Evaluation", "Subsidized housing", and "Supportive housing" (19). The databases used were PubMed, Google Scholar, Google, and the Homeless Hub. The review is presented as a separate chapter after the literature review section of the thesis.

For the second objective, to perform the cost-effectiveness analysis, data from the At Home/Chez Soi (AHCS) multisite randomized control trial (RCT) study conducted from October 2009 to March 2013 in five Canadian cities (22, 23) were used. Baseline interviews for Montreal participants in that study were conducted between October 2009 and May 2011, and participants were followed for 21/24 months. At that site, after March 31, 2013, HF services were reduced following the end of federal funding. Participants were interviewed about 48 months post-baseline (in actuality, from February 2014 to October 2015) to assess, among other variables, their residential history and use of health, social and justice services (including HF services) as well as their income during the six months prior to the interview.

Effectiveness was measured using days of stable housing as previously done in most HF studies. A cost-effectiveness analysis was conducted using a modified societal perspective. All costs are reported in 2022 Canadian dollars.

2. Literature Review

This literature review aims to synthesize and summarize the literature regarding 1) background information on homelessness including definitions and causes, 2) health and justice outcomes related to homelessness, 3) costs of homelessness, 4) policies and initiatives to address homelessness, 5) HF, 6) qualitative and quantitative outcomes related to HF, and 7) the AHCS study. A separate chapter, to be submitted as a manuscript, summarizes the literature on cost offsets associated with HF as well as its cost-effectiveness.

2.1 Causes of homelessness

In 2016, homelessness was estimated to affect 235,000 people each year in Canada (1). Since then, the number of people experiencing homelessness has increased, with some communities seeing an increase greater than 100% (or even more) of those experiencing what is termed "absolute homelessness" (defined below) from 2020 to 2022. In Québec, homelessness was estimated to have increased by 44% between 2018 and 2022. Between 2020 and 2022, the sheltered population grew by 3% (3).

In Canada, homelessness is defined as a situation where an individual is unable to obtain a permanent, stable, and safe residence (24). Quebec has a similar definition, but adds that homelessness is influenced by one's social status and emphasizes that these individuals are socially excluded from the community (25). Experiences of homelessness vary by individual or sociodemographic groups as some have a temporary accommodation (e.g., staying with family or friends or in emergency shelters or transitional housing) while others are sleeping rough (e.g., staying on the streets, tents, and alleyways) (26). Due to heterogeneous experiences of homelessness, these experiences have been categorized as follows (24):

- 1. Unsheltered or absolute homelessness: individuals living in places not meant to be habituated (e.g., a car, sidewalk, or tent).
- 2. Emergency sheltered: individuals who reside in short-term housing provided by institutions at little to no cost to the user. For example, homeless shelters, shelters for battered spouses, and family shelters.
- 3. Provisionally accommodated or hidden homelessness: Short-term accommodations that allows individuals to be housed with conditions for a set period. Examples of these are hotels or transitional housing facilities.

4. At risk of homelessness or precariously housed: People who may be on the cusp of experiencing homelessness.

The causes of homelessness are numerous and vary greatly across individuals. Homelessness is usually due to an interaction among individual, systemic and structural factors (27). Specific sub-populations, such as LGBTQ2S+ and males have an increased risk of experiencing homelessness (28). Disabilities that affect cognitive, psychological, and physical health increase the risk of homelessness (29, 30). In Canada, those who have a disability are twice as likely to experience homelessness compared to those who do not have a disability (30). Various mechanisms appear to underlie this association. PEH who have cognitive disabilities or mental illness attributed their having lost their housing to experiencing difficulties with family relationships, and among those with cognitive disabilities, the lack of relationships was a reason for becoming homeless (29). Further, PEH with a learning disability and a mental illness also mentioned that lack of finances led to them becoming homeless (29). PEH tend to rely heavily on disability benefits and social assistance (6), however, the amounts provided are generally below living expenses (31). As well, disability has been associated with a lower income (32), most likely due to difficulties in participating in the workforce (33).

Various experiences can contribute to future episodes of homelessness (28, 34). Experiences such as family breakdown (28, 34), history of foster care (28, 34), unemployment (28), low educational attainment (28), psychiatric illness (28, 34), suicidality (28), and violence (28, 34) are associated with an increase in the risk of having an episode of homelessness. Additionally, adverse early-life experiences, such as childhood poverty (35), physical abuse (28, 34), and experience in foster care (28, 34), have also been associated with homelessness. Further, more adverse childhood experiences are associated with longer episodes of homelessness (36). Young adults aging out of the youth protection system are relatively likely to experience homelessness (34, 37), as these individuals tend to have fewer years of education and less social support (38). In Quebec, 33% of youth experience an episode of homelessness before the age of 21 after leaving foster care (38). While individual characteristics and negative life experiences can affect the likelihood of experiencing a future episode of homelessness (28), systemic factors can contribute to this risk as well (34, 39).

Systemic factors are external influences that compound the individual risk, which worsens the likelihood and duration of experiencing homelessness (34, 40). For example, racial and ethnic

minorities are overrepresented in the homeless population as systemic factors can limit their ability to obtain and keep safe and affordable housing (41, 42). Structural factors that affect homelessness can include a lack of affordable housing (10, 34, 40), poverty (40), and discrimination (40). Affordable housing, in Canada, is defined as a residence where the rent/payment is not above 30% of the household's income (before taxes) (43). Affordable housing is critical as communities with high rents and low supply of affordable or subsidized housing have a greater prevalence of homelessness (44, 45). Further compounding this situation is an ever-growing demand and waitlist for affordable housing (11). As well, the waitlist for supportive housing, affordable housing with case management (46), is particularly long for those suffering from severe mental illness, with a wait time up to 5 years (11). One reason for the reduction in the supply of affordable housing is the growth of gentrification (12). Gentrification is defined as the displacement of low-income individuals due to an increased population of wealthier individuals in a given community (Rose 1964: cited in Feldman 2016 47). Gentrification has also been associated with negative outcomes related to housing stability. For example, among people with substance use, those who lived in areas with greater gentrification had a 10% increase in odds of experiencing homelessness compared to those in less gentrified communities (48). As more income is allocated to housing, there is a decrease in spending on other necessities such as food, clothing, and utilities (49). When this is coupled with a poor labour market, lack of affordable housing, and lack of governmental support programs, the susceptibility to experiencing homelessness is increased (50). Poverty relates to affordable housing as the lack of affordable housing means that those in poverty are at increased risk of homelessness (51). Canada does not have an official definition for poverty, however, low-income is defined as being 50% below the median Canadian household income (52). Low-income is also used by other countries to compare poverty rates and can be used interchangeably with poverty (53). In 2016, Canadians experiencing poverty were more likely to experience negative housing outcomes such as living in poor quality and unaffordable housing (54). Many challenges are associated with poverty as those experiencing poverty are priced out of the housing market being both socially and economically excluded from society (55). Social exclusion is defined by the United Nations as a state in which people are unable engage in society's economy, culture, politics, and social life (56). Social exclusion can affect PEH' ability to obtain financial resources, such as when disability and welfare, benefits are rescinded once a person secures other sources of income (57). Discrimination has also been identified as a structural

contributor to homelessness (40). Housing discrimination is discrimination that limits certain groups' opportunities of accessing housing or when they are unfairly treated in the housing market (58). This type of discrimination is frequently experienced by Indigenous people (58) and racialized groups (59). Additionally, this type of discrimination can lead to homelessness due to social exclusion (60). Homelessness can be due to systemic barriers that interact with individual contributors (40) and needs to be prevented as it negatively impacts health outcomes and mortality (4, 61).

2.2 Health outcomes related to homelessness

Homelessness has been associated with negative health outcomes and a higher mortality rate compared to the general population (4, 61). Among PEH, the age-adjusted prevalence of chronic obstructive pulmonary disease, tuberculosis, HIV, Hepatitis C, cardiovascular disease, and mental illnesses, among others, is higher than in the general population (4). Homelessness has also been associated with an increased rate of drug overdose deaths among young adults (62, 63) and premature death among older PEH (62).

Mental illness is highly prevalent in the homeless population compared to the general population (64-67), and PEH with mental illness tend to have longer episodes of homelessness than those without mental illness (41). As well, PEH have higher readmission rates to psychiatric hospitals within 1-month post-discharge compared to the general public (68). Reasons for these health outcomes could be due to an increase in exposure to extreme weather conditions (69), lower social status (70), and exposure to violence (71). As previously mentioned, PEH tend to be socially excluded from society (72) and social exclusion has been associated with more negative health outcomes (73). Further, experiencing an episode of homelessness can inadvertently lead to more negative social interactions such as discrimination and violence (74). For example, between 27-38% of PEH reported being victimized in one year (75). Among people experiencing hidden homelessness, social exclusion was associated with less healthy behaviors such as eating less than one meal, current substance use, and substance use before the age of 15 (76).

2.3 Justice outcomes related to homelessness

PEH, especially those living with mental illness, tend to have more frequent interactions with the justice system (7, 8) compared with their housed counterparts (77, 78). This may result from PEH using survival strategies (e.g. breaking into a building), although these crimes tend to be non-

violent (79). Being incarcerated also increases the risk of experiencing an episode of homelessness, suggesting that there is a cyclical pattern (80).

2.4 Costs associated with homelessness

PEH tend to frequently interact with the health, justice, and social services systems, which generates costs for society (8, 9). It is estimated in large Canadian cities that annually, PEH with mental illness use on average \$60,000 (per person per year) worth of health, justice and social services, including social assistance and disability benefits (9). Some of these costs are attributed to more frequent use of high-cost health services such as ER visits and less frequent use of low-cost outpatient services (8). As previously mentioned, PEH are more likely to have a disability that limits their ability to participate in the labour force market (81). For this reason, these individuals rely heavily on social assistance and disability payments as their sole income (6). Also, across four Canadian cities, it was estimated that the institutional cost (defined as costs per day of stays in a jail, prison, or psychiatric hospital) per PEH ranged from \$200 to \$600 (82). Due to the high costs generated from experiencing homelessness, Canada has introduced policies to reduce the number of PEH (10, 83-87).

2.5 Responses to homelessness

Due to the negative economic and societal impacts of homelessness, Canada has attempted to address homelessness using different policies (10, 83-87). In Canada, the current worsening homelessness situation is a result of policy changes that occurred in the 1980's and 1990's. These policy changes include deinstitutionalization and the dismantling of federal social housing funds, affecting the number of affordable housing units today (10, 83). In Canada, deinstitutionalization was a movement in psychiatry where patients were transferred from psychiatric institutions to more or less reliable community-based supports starting in the 1960s (88, 89). However, due to lack of proper discharge planning and of sufficient ongoing community supports, this shift led to many people living with severe mental illness (SMI) to experience homelessness (90). Homelessness became a larger issue in the 1980s and 90s due to the termination of social housing development by the federal government and reductions in unemployment insurance (91). As visible homelessness became a concern in the 90s and following (10), the government response at the time focused on developing and providing services that address short-term episodic homelessness rather than preventing and addressing chronic homelessness (10, 87). Meanwhile,

the *National Homelessness Initiative* was developed around this time to help communities respond to homelessness (84).

The current federal government has developed different policies and programs to address homelessness (84). In 2019, the Canadian government implemented Reaching Home, which aims to reduce chronic homelessness by half by 2027-2028 by funding different homelessness programs for vulnerable populations (85). In addition, a one-time housing assistance of \$500 per low-income renter was also provided by the federal government in 2022 (86). Provinces such as Quebec, British Columbia, Manitoba, Ontario, and Prince Edward Island have implemented policies such as rent control to regulate rental costs and offer protection to tenants from high rent increases (92, 93). However, rent control has unintended consequences where landlords respond by reducing the number of rental units available (92). By doing this, the supply of rental units can decrease which can then increase the cost of rent (92). Moreover, rent control reduces tenants' mobility as those with rent-controlled units retain them even when there is a mismatch regarding housing need due to lack of rent-controlled units (92). In addition, there have been demands to increase social assistance across provinces (94-96), though, increases in social assistance have little to no impact on the prevalence of homelessness (45), unless the increases matches market level rental prices (50). An adequate supply of social housing has been associated with a decreased risk of homelessness (97). In Canada, due to the end of social housing funding from the federal government, housing became a sector overseen by the provincial government (98). Québec developed the Accès-Logis program which has helped to increase the affordable housing stock and constructed 17,470 affordable homes from 1997 to 2010 (99). Provinces such as Ontario chose to delegate social housing responsibilities to its municipal governments (100). However, these decisions have lead to little growth in social housing in two of the largest Canadian cities (Toronto and Vancouver) from 1991 to 2011 (12). Furthermore, Canada has less social housing stock (3.5%) (101), the proportion of social housing out of all available housing units, compared to the average Organisation for Economic Co-operation and Development country (7% in 2020) (102). Overall, Canadian policies at both the federal and provincial level have had little impact on decreasing the number of PEH; rather, growth has been witnessed due to a lack of funding for policies that prevent homelessness (10) and increase the supply of social housing (11, 12). Canada has yet to find a solution to homelessness.

Finland has, however, been successful at developing policies and initiatives to address this issue. Finland has a history of implementing policies to address homelessness in an effective manner (13). Since the late 1980s, Finland has supported non-profit organizations to develop supportive housing units (13) and increase collaboration between health and social services to help support PEH (103). As well, The Act on the Development of Housing Conditions of 1985 was a policy to improve the quality of housing for PEH (13). In addition to this, a right to housing was added to the Finnish constitution in 1995 (13). Ultimately, these policies resulted in a 60% reduction of PEH between 1987 and 2008 (13). In 2008, a program focused on reducing long-term homelessness was implemented to help those experiencing chronic homelessness with mental illness exit homelessness using an approach based on the Housing First (HF) model (13, 14). Longterm homelessness in Finland is defined as an individual experiencing homelessness for more than a year or having multiple episodes of homelessness within a 3-year period (13). Following the recession of 2008, the Finnish government decided to allocate funds to an approach based on the HF model (104), which was developed in 1992 by an American psychologist named Sam Tsemberis, that provides rent subsidized apartments and community-based supports to PEH (105). The Finnish policy differed from other international policies by allocating funds towards the development of permanent affordable housing for those experiencing homelessness instead of transition and emergency shelters (104). Through this policy, temporary accommodations were almost completely removed and these institutions were converted into apartment complexes with support teams on-site to provide assistance (13, 104). In addition, individualized treatment plans were provided along with accommodation and eviction prevention services (13), peer support was included to enable PEH to integrate into their communities (13). By 2016, only 52 emergency shelter beds remained in Finland, while over 3,000 units were used for supportive housing and apartments for formerly homeless people (106). After 2011, the focus was on preventing people from experiencing homelessness and expanded the target population to include those in precarious homeless situations (107). The policy fostered social inclusion by treating PEH as people rather than as patients and by nurturing participation in their community (108). By 2021, the number of PEH was 3, 948, mostly in hidden homelessness situations (14), compared to less than 8,000 PEH in 2007 (109) which demonstrated that the initiative was successful. To understand why HF was successful in Finland, the history of HF and the empirical evidence associated with HF needs to be discussed.

2.6 Housing First

Homelessness has been predominately addressed using a treatment-first approach (110). The treatment-first approach has PEH focus on improving their sobriety from alcohol and/or substance prior to transitioning to a more stable form of housing. Eventually, participants can obtain a permanent stable residence once they have achieved full sobriety and independence (105). This approach makes housing conditional on adhering to sobriety (16). Treatment-first programs take different forms, the most common of which is congregate housing with onsite treatment (110). However, this approach has little evidence of being successful in treating PEH living with SMI as this approach was not associated with an increase in housing stability when compared to independent housing with case management (111). Further the strict regulations can increase instability in the lives of PEH with SMI and lead to them disengaging with this approach (112). Moreover, participants would prefer an independent living arrangement rather than in a treatmentfirst congregate housing situation due to their distrust of psychiatric services and rules that limited their autonomy (105, 112, 113). This approach can also have difficulties in helping those with multiple and complicated psychiatric comorbidities and housing needs due to insufficient support on the providers' side (111). As an alternative approach, Sam Tsemberis founded *Pathways to* Housing in New York in 1992 (114, 115) to better assist people with exiting homelessness and reintegrating into their communities (105). The Pathways to Housing approach, which came to be known as Housing First (HF), focuses on allowing participants to have housing while being able to voluntarily participate in a sobriety treatment (105). HF combines rent supplements, where the person only pays 25% or 30% of their income (the latter if heat is included in the rent) towards rent in an ordinary rental market apartment that the participant has helped choose, with the ongoing support of a multidisciplinary treatment and rehabilitation team (15). Community-based supports are also provided by a multidisciplinary team (15) which can be Assertive Community Treatment (ACT) or Intensive Case Management (ICM) depending on the amount of support an individual needs (4, 5). These supports help people in the HF program integrate back into society by assisting the development of their social skills and job skills while treating their mental illness (4, 6). HF has eight principles (116):

- 1. Housing is a human right;
- 2. Treat clients with respect, warmth, and compassion;
- 3. Provide support to clients as long as they need it;

- 4. Provide scattered-site apartments (not congregate);
- 5. Separate housing from support services;
- 6. Allow for client choice and self-determination;
- 7. Focus on recovery;
- 8. Take a harm reduction approach;

Findings from multiple studies found that HF allows PEH to enter stable housing faster and keep it for longer compared to treatment as usual (TAU) (17, 20-23, 105, 117-123) which is often defined as any other service outside of HF (9, 115). HF has also been associated with other positive outcomes such as community functioning (22), social integration (124), and quality of life (18, 22, 23, 125). An RCT study conducted in France also found that 6% of HF participants no longer needed HF services after 2 years (126) suggesting they were able to exit homelessness with the help of HF. TAU participants are more likely to engage in a sobriety program compared to HF participants (17, 105), however, there was no difference on physical (17) and mental health outcomes (17, 105) between TAU and HF. HF has been associated with positive outcomes such as increased housing stability (17, 20-23, 105, 117-123), quality of life (18, 22, 125), and social integration (124), leading to an interest in the economic impact of HF.

2.7 Economic Outcomes of Housing First

Several studies have examined the economic impact of HF. A literature review conducted in 2015 reported that for PEH living with mental illnesses and veterans experiencing homelessness, HF was associated with cost offsets from reductions in ED visits and in-patient service use. However, the cost offsets reported in the more rigorous studies tended to be less than the cost of the intervention (19). Since the publication of this review, several additional studies on the economic impacts and cost-effectiveness of HF have been reported. A systematic review of these studies was conducted to address the first objective of this thesis. It is presented as a manuscript in chapter 3.

2.8 The At Home/Chez Soi study

We now describe the AHCS study, including the evolution of services at the Montreal site, in some detail in order to provide context for the cost-effectiveness analysis which is presented starting in section 4. The AHCS study was a research and demonstration project (115) designed to test the HF model (22, 23). Nine concurrent randomized trials (N = 2,148) were conducted in Vancouver (n = 390), Winnipeg (n = 513), Toronto (n = 575), Montreal (n = 469), and Moncton (n = 201) between October 2009 and March 2013; with recruitment occurring between October 2009 and

May 2011 (127, 128). Individuals were classified as high needs (HN) or moderate needs (MN) based on their baseline characteristics, then randomized to either HF or TAU (115, 128). All participants were initially followed for up to two years. Days of stable housing was used as the outcome measure, defined as living in an apartment, social housing, or staying with one's family or friends for more than 6 months. After two years, the study showed that HF was more effective than TAU at increasing housing stability (22, 23). Qualitative interviews on 197 participants indicated that the intervention helped most participants experience more positive life changes during the two-year follow-up period (HF: 61% positive, 31% mixed-neutral, 8% negative vs TAU: 28% positive, 36% mixed-neutral, 36% negative) (18). The HF intervention cost \$20,367 per person per year on average, and 69% of those costs were offset by reductions in the costs of shelters and other services (20). For MN participants the corresponding numbers were \$14,496 and 46% (21).

After March 31, 2013, when federal funding ended, at the Montreal site, HF participants in some cases were able to continue to receive rent supplements, support services (ACT or ICM), or both. In other cases, they lost all HF services. A follow-up of the Chez Soi participants (N = 362, 78% of the original sample) was conducted in Montreal at about 4 years post-randomization (between 11 months and 31 months following the end of federal funding). At that point, some participants originally assigned to HF were still receiving both rent supplements and support services; others had stopped receiving one or both, while others were between these two extremes. Preliminary results indicated that during the 6 months before the interview, days of stable housing were still somewhat higher in the original HF group than in the TAU group for MN participants, but they were virtually identical in the HN group versus the TAU group. Results regarding costs and service use at 48-months had not yet been analysed at the time this thesis was undertaken.

Most economic analyses have not been conducted on HF for a follow-up period of greater than 3 years (19). Furthermore, it is unknown if HF remains cost-effective once services have been reduced. One study examined changes in health, social and justice services after loss of HF services at 3 years and found a reduction in services such as ED visits, in-patient psychiatric stays, and in-patient hospital stays by the 4th year. However, it was unknown how these changes in services affected costs (129). The Montreal data provides an opportunity to examine the cost-effectiveness of HF at 43-48 months post-randomization and to examine how the reduction of services affect service use and costs.

2.9 Summary

This literature review has provided information on homelessness, factors associated with homelessness, health and economic outcomes of homelessness, policies used to address homelessness in Canada and Finland, the Pathways HF program model, outcomes related to HF and the economic impacts of HF. The definition of homelessness was given in both the Canadian and Quebec context along with demographic information. Canada has attempted to reduce the number of PEH, with at best limited success to date. Finland has adopted a comprehensive approach that includes a type of Housing First and has been much more successful.

HF, an intervention to help PEH with mental illness through immediate access to scattered-site permanent housing with community supports, was described. HF has been shown to increase acquisition and retention of permanent stable housing. Further, qualitative outcomes such as quality of life and mental well-being have increased for participants using HF. Additionally, HF can generate cost offsets for ED visits, shelter use, and ambulance use, though these studies, in most cases, typically had a short duration of 2 years or less.

The AHCS, multisite RCT study on HF was described. The study found HF with ACT for HN participants was \$42 per day of stable housing, and HF with ICM for MN participants was \$56 per day of stable housing, and effective in promoting health and well-being for those experiencing homelessness. However, following the end of federal funding, HF services were reduced at the Montreal site. Participants were followed up at 4 years, but costs and service use has not been analysed.

This review indicates that homelessness is both a public health and economic concern. Though policies have been developed to mitigate, reduce, or end homelessness, homelessness has become a global issue with negative outcomes to society. HF can be considered part of the solution due to its ability to increase long-term housing stability and mental well-being for those experiencing both homelessness and mental illness. A 2015 literature review reported that HF can generate cost offsets, though they tend to be less than the cost of the intervention. An updated literature review has not been conducted since, despite several studies having been reported since. Thus, a systematic review was conducted and is presented as a manuscript in the next chapter. In addition, few studies have examined whether HF can remain cost-effective when services are reduced. Further, studies tend to analyze HF up to 2 years or less, thus it is unknown if cost offsets change with increasing duration. Sections 4 to 6 of the thesis examine the cost-effectiveness of HF after a

partial cessation of services at 43-48 months, by need level. Evidence emerging from this analysis may strengthen support for measures designed to enhance funding for and fidelity to the HF model.

3. Manuscript presenting an updated literature review on the economic impacts of Housing First

To provide an up-to-date literature review of the economic impact of HF, a systematic review was conducted and presented in one manuscript.

Economic impacts of Housing First for people with mental illness experiencing homelessness: An

Updated Review of the Literature

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Abstract

Objective. To provide an updated literature review, building upon one published in 2015. Methods. A systematic review was performed on MEDLINE, and Google Scholar and the Homeless Hub repository for grey literature, from January 2007 to January 2023. Keywords included "Housing First", "Cost-effectiveness", "Cost-analysis", "Cost", "Economic Evaluation", "Subsidized housing", and "Supportive housing". Data extracted included study design, economic perspective, sample size, population, duration, service use, cost offsets, and nature of the intervention. The use of health, social, and justice services was extracted, as well as government benefits. The first author identified relevant studies in collaboration with the second, and carried out data extraction, referring to the second when in doubt. Results. Nineteen peer-reviewed (five experimental, two modeling, and twelve quasi-experimental) and two grey literature articles were identified. Shelter, emergency department, and in-patient costs decreased with HF, while impacts on other health and on justice costs remained unclear. One of three pre-post studies that considered the cost of the intervention reported a net decrease in overall costs with HF. In contrast, quasiexperimental studies with a comparison group reported an increase in net costs. Experimental studies reported a net increase (4/5) or neutral (1/5) effect on overall costs. Two modeling studies projected that HF would be associated with decreased or marginally higher net costs over a 10and 35-year horizons. Conclusion. Considering the greater validity of experimental designs, the updated literature review suggests that over a two-year horizon, HF leads to significant cost offsets that may equal, but are unlikely to exceed, the intervention cost. Modeling studies suggest HF may or may not be cost saving in the long run. HF remains an effective and relatively inexpensive intervention, but it should not be expected to fully pay for itself, at least in the short run, similar to most health care interventions.

Keywords: homelessness, mental health, Housing First, cost, cost-effectiveness, economic analysis, service use, supported housing, supportive housing

Abbreviations

ACT: Assertive Community Treatment

AHCS: At Home/Chez soi

ED: Emergency department

HF: Housing First

ICM: Intensive case management

ICER: Incremental cost-effectiveness ratio

PEH: People experiencing homelessness

SMI: Severe mental illness

TAU: Treatment as usual

USA: United States of America

Introduction

Launched in New York City in 1992, the Pathways approach to Housing First (HF) emphasizes consumer choice and hence a reliance on scattered-site apartments, as a key tool to address homelessness (105, 114, 115). HF combines rent supplements, where the person only pays 25% or 30% of their income towards rent in an ordinary rental market apartment that the participant has helped choose, with the ongoing support of a multidisciplinary treatment and rehabilitation team (15). Community-based supports can be in the form of Assertive Case Treatment (ACT) or Intensive Case Management (ICM) depending on the amount of support an individual needs (4, 5). These supports help people experiencing homelessness (PEH) with severe mental illness (SMI) remain stably housed and, ideally, integrate back into society by assisting the development of their social skills and job skills while addressing their mental illness and/or addictions (4, 6). HF differs from traditional homelessness interventions as it allows PEH to obtain housing while being able to voluntarily participate in substance use treatment though such participation is not required (105). HF has been shown to help PEH enter stable housing faster and keep it for a longer period compared to "Treatment As Usual" (TAU) – whatever services are available other than HF (20,

21, 105, 117-123). Additionally, HF has been associated with positive outcomes such as mental well-being (123) and quality of life (18, 22, 23). HF can also generate cost offsets decreasing the net cost of the intervention as found in a literature review that was conducted in 2015 (19). The literature review also found: pre-post studies indicate HF as cost-saving, likely due to regression to the mean; quasi-experimental studies with a comparison group are equivocal while experimental studies tend to show cost offsets less than the cost of the intervention (19). Since its publication, several additional studies have been conducted including in France, Spain, and Australia using both experimental and quasi-experimental designs, to determine the impact of HF or its variants

on costs (122, 126, 130-132). However, a review using all studies published after 2015 has not been conducted.

The objective is to provide an updated literature review, building upon the one conducted in 2015.

Methods

A similar search strategy as the 2015 literature review was used (19), with the exception that Google Scholar was used rather than PsycInfo to broaden the search. Dates were restricted from January 2007 to January 2023. The search started earlier than 2014 to check for studies that might have been missed in the previous review. The same keywords used in the 2015 literature review were used for this review which included "costs", "Housing First", "economic evaluation", "subsidized housing", "supportive housing", "costs and cost analysis", "cost-benefit analysis", "housing", "homeless persons", "mental health", "mental disorders", "economics", "cost", "financing" (19). A similar search strategy was adopted with the Homeless Hub, an online database of peer-reviewed studies, reports, and other grey literature material regarding homelessness (19). Additional studies were also identified by experts whom we consulted. Theses were also included. Studies reporting cost data were included regardless of economic perspective, stated or unstated.

The same data were extracted as in the previous literature review: location (country, city, state/province), study design, population, sample size, nature of the intervention, duration of follow-up, economic perspective (when available), key observations (regarding potential sources of biases and methods used to address or prevent biased results), service use, cost offsets, and incremental cost-effectiveness ratios (ICERs) (when available). Similar to the previous review, when available, the cost of the intervention and whether it was included in reported total costs was reported (19). The use of health, social, and justice services was extracted, as well as government benefits. Service impact was measured in the same way as in the 2015 literature review (19) with

the exception of including cost of prescription and skilled nurse facilities in health care costs. Other costs such as welfare and disability benefits were included in this review along with the impact on net costs.

When extracting data from publications, housing model was differentiated between single-site (also known as congregate housing) with on-site supports and scattered site, in which a mobile team provides support. This had not been done in the 2015 review. When available, we included a description of the support intervention, which could be ACT, ICM, or case management. The first author identified relevant studies and carried out data extraction, referring to the second when in doubt.

Results

Figure 1 shows the PRISMA Diagram. Prior to excluding duplicates, 15,743 publications were found. We excluded a Canadian study, an English study, and the final report of the HF Europe study since these publications only use cost of shelter bed or compared cost of intervention to the cost of a shelter bed (133-135). We excluded four reports from England as they did not base their economical analyses on any empirical evidence (135-138). Other reasons for exclusion included: the population was not experiencing homelessness, the publication was not in English, and no formal cost analysis was carried out. Twenty-one articles from both the academic and grey literature were selected. Five were experimental studies, two were modeling studies, seven were quasi-experimental with a comparison group pre-post design, and seven were quasi-experimental pre-post only. The two modeling studies used data from two of the experimental studies, one from the At Home/Chez Soi (AHCS) Montreal site, modeling over a 10-year time frame (126). Two articles

published prior to 2015 and not included in the original review were identified, one using a quasiexperimental design with comparison group (140) and the other a pre-post design (141).

Tables 1.1 and 1.2 show the study characteristics from all studies (except modeling studies) selected using the criteria described in the methods section. More than half of the selected studies recruited PEH with SMI (20, 21, 53, 122, 126, 130, 131, 139, 140, 142-145). A wide range of populations were found in this review with one study that recruited foster youth transitioning out of care (146) and another that recruited seniors experiencing homelessness (141). Two studies targeted people who frequently use the justice system and homeless shelters, though with varying definitions. One was defined as those who have four jail and four shelter stays within the past five years (140). The other defined as people experiencing homelessness who had 8 or more arrests over 3 consecutive years, at least 3 of which while homeless (147). Experimental studies tend to have large sample sizes, aside from the Spanish study which had a smaller sample size (n = 255). The Spanish study also suffered from a large differential attrition with 50% of the control group lost to follow-up compared to 24% of the experimental group, potentially biasing results (130). The Denver study also suffered from selection bias as only HF participants who could be located within 24 hours could enroll in the study (147). This recruitment procedure might lead to an attenuation of the treatment effect as those who are more difficult to locate might be systematically different than those who were located quickly. Aside from these, the experimental studies, particularly the AHCS and French study, implemented strategies to address missing data or biases such as multiple imputation and allocation concealment (20, 21, 122). These methods increase the certainty of their evidence.

The intervention was similar across the experimental studies where HF (scattered-site, the only exception being the Denver study which used a mix of congregate and scattered site housing) and

ACT or ICM was provided (20, 21, 122, 148). However, for quasi-experimental studies, with and without comparison group, the intervention varied, though all provided a rent-subsidized dwelling (53, 131, 132, 140-142, 144-146, 149-153). Among the pre-post studies with a comparison group, two had a mix of scattered-site and single-site housing with either on-site or off-site supports, (146, 153), three had only single-site housing with on-site supports (140, 144, 151), one had scattered-site housing with off-site supports (152), and the last was unknown due to a lack of description (53). For pre-post only studies, five used single-site housing with either on-site or off-site supports (131, 132, 141, 145, 149), one used a mix of single-site on-site and off-site supports (150), and the last one was unknown due to lack of a description (142). Comparison group participants in quasi-experimental studies were assigned to usual services (140, 141, 144, 146, 151-153). In the case of youth transitioning out of foster care, HF programs were divided into 3 fidelity categories (low, medium, high). These categories represent how closely these programs followed the HF model. Costs were estimated by fidelity level as well as compared with the TAU group (146).

Experimental and modeling studies, except for one, used self-report questionnaires completed by participants (20, 21, 122, 130). A Denver study used linked administrative datasets to estimate costs (143). Quasi-experimental studies with or without a comparison group tended to collect data from administrative databases (53, 131, 132, 140-142, 144-146, 149-153), mainly when using health care or Medicare or Medicaid economic perspectives (141, 142, 144-146, 151-153). In these cases, the health services they included varied. For example, while Hollander et al., (2021) included only those categorized as behavioral health, physical health, and prescription drugs, most studies combined at least some data from the health care services such as emergency department (ED) visits, in-patient, outpatient, and prescription drugs (53, 131, 132, 140, 142, 144-146, 149-152).

All the experimental and modeling studies, except the Denver study, used a modified societal perspective, which includes the cost of social assistance, and the AHCS studies also included employment income. Most quasi-experimental studies used a health care perspective (141, 142, 144-146, 151, 152). Five studies did not state the perspective they used, but the types of costs included indicate that they took a perspective approximating that of the government (132, 149, 150) or health insurer (53, 131).

All experimental and modeling studies except two estimated the ICERs using days of independent or stable housing (20, 21, 126, 139), apart from the Spain study which used three measures of effectiveness: general satisfaction, nights of homelessness, and percentage increase in the institutional residential coverage rate (homeless shelter/homeless organization) (130). Qualityadjusted life years were not used as a measure of effectiveness in any study. Quasi-experimental studies estimated and compared cost of services incurred by one group that received HF compared to those who did not (in pre-post only studies, this was the same group prior to receiving HF).

Table 2.1 provides the results extracted from the experimental studies. Experimental studies generally reported cost offsets that were approximately half of the intervention's cost (20, 21, 130, 143), except for the study conducted in France, which found that the intervention's cost was completely offset (122). Four of the five experimental studies reported an increase in net costs for HF compared with control groups (20, 21, 130, 143). Only the French study found that HF had a cost neutral effect on net costs (122). The two modeling studies suggested that over the long term (10 years or more), HF programs can lead to high cost offsets, almost fully or more than fully offsetting the cost of the intervention. The modelling techniques differed between the two studies.

The 10-year modeling study, which relied on the AHCS Montreal site specific data used three transition states (stably housed, unstably housed, and death) and determined transition states over
a 30-day period. The study also assumed that HF participants would become more independent and use less of the ACT and ICM (depending on the need level) decreasing case management service use by 2.5% per year. The conclusion of this modeling study was HF was cost saving compared to TAU (139).

The 35-year modeling study used data from of all five cities included in the French study, with the same transition states as the Montreal modeling study. While the Montreal study used a cycle length of one month, the data collection instrument used in France was less precise and a cycle length of six months was used. The authors assumed the cost of the intervention would decrease following the first 2 years to 75% in year three, 60% in year four to 50% for year 5 until year 35. Their findings suggests that HF would cost \in 5.3 per day of stable housing. The authors found greater costs in social assistance and social services and decreased costs in health care and residential services (defined as costs for shelters and supportive housing) (126).

Table 2.2 provides the results extracted from the selected quasi-experimental studies. Six of seven quasi-experimental studies with comparison group found a reduction in health costs by the end of the follow-up (53, 140, 144, 151-153), however, when stratified by type of service, findings varied. Three out of seven reported reductions in ED visits (140, 144, 151) while four out of seven reported inpatient psychiatric costs (140, 144, 151, 153) following 1-3 years of entry into HF compared to TAU. A study on youth transitioning from foster care had higher health service costs in the HF group compared to TAU (146). Two studies found that health costs were reduced similarly at the end of follow up for both the HF and TAU groups (53, 152). Three of the quasi-experimental studies with comparison group considered the cost of the intervention and reported that net costs were higher than TAU (53, 140, 152). The cost offsets were not more than the cost of the intervention (53, 140, 152). One study reported that the cost of the HF program was offset by 61-

66% (depending on the perspective) due to reduction in health and justice costs (140). Some quasiexperimental studies with comparison group also found increased outpatient (146) or pharmaceutical costs (151) or both (153). Almost all pre-post studies with a comparison group, aside from Dobbins et al. (2021), used propensity score matching or weighing to address potential characteristic differences between the experimental groups and control groups (140, 144, 146, 151-153).

Pre-post studies generally found decreased health (131, 141, 142, 145, 150), justice (132, 149, 150), and shelter (132, 149) costs. However, one of the pre-post studies found mixed results for health services as only one of the HF sites found a decrease in health costs while the other had increased health costs (149). When net costs were considered, one study found a reduction (141), while the other reported that the cost savings only offset 60-90% (depending the perspective) of the cost of the intervention (131, 132). With the exception of the Calgary study (150), sample sizes were small (n < 100) reducing the confidence in the results (131, 132, 141, 142, 145). Additional concerns regarding the accuracy of cost estimates came from the administrative data as not all service utilization could be captured (132, 142, 149). In some cases, up to 30% of participants used services at a hospital that was not part of the administrative dataset leading to an underestimate in costs (142).

Discussion

This updated literature review has identified twenty-one studies, conducted in various countries using both experimental and quasi-experimental study designs to evaluate the economic impact of HF. Similar to the 2015 literature review, HF was found to generate cost offsets for PEH with SMI, though most were less than the cost of the intervention (20, 21, 53, 122, 126, 130, 131, 140, 142-145). This pattern was also consistent for PEH who were not selected for having mental illness

(132, 149-153) and for seniors experiencing homelessness (141). Only one study, which included youth transitioning out of foster care (146), reported no cost offsets at all. Shelter costs decreased as the intervention provides an alternative place to stay for participants (20, 21, 122, 131, 132, 140, 143). ED costs were also consistently found to decrease most likely since case managers are able to anticipate and prevent crisis situations requiring an ED visit (20, 21, 122, 131, 140-142, 145, 150). Studies in this literature review included diverse populations, such as seniors experiencing homelessness (141) and youth transitioning from foster care (146). In contrast, the previous review included exclusively individuals experiencing homelessness with SMI and US veterans experiencing homelessness (19). Two pre-June 2015 studies were missed in the 2015 literature review, one using a pre-post design with seniors experiencing homelessness (141), and the second study a quasi-experimental design with a comparison group among high-cost users who were either at risk of or experiencing homelessness (140). Including these studies in the previous review, would have strengthened the conclusion that HF is associated with decreased ED visits (140, 141), shelter (140), and justice costs (140). Both studies found that the cost of the intervention was offset by 61.4% to 100% depending on the perspective (140, 141).

Whether costs for a particular type of service increased or decreased depended on the service. Costs of out-patient (146) or pharmaceutical costs (151) or both (153) increased while in-patient psychiatric services (140, 144, 151, 153) and ED visits (140, 144, 151) decreased in quasi-experimental studies with comparison groups. The one exception was with youth transitioning out of foster care as all health service costs increased and health costs were higher for program with higher HF fidelity (146). The author suggested that HF might not be the best program for youth transitioning out of care; however, the increased use of outpatient psychiatric services potentially shows that HF is encouraging youth to seek much needed services (146). As well, two studies

reported that while health costs decreased at follow-up, they were not significantly different from those of the TAU group, and HF groups had higher health costs compared to TAU (53, 152). One of these studies had a small sample size, reducing the reliability of this finding (53). The other study suggested that immediately after participants in the HF group had entered the study, the period prior to receiving a stable accommodation was longer for some participants, increasing costs during the follow-up period. Once all participants were housed, health costs were less for HF recipients than for the TAU group, but the net cost, including the cost of the intervention, was higher (152). Only one quasi-experimental study with comparison group used a societal and public payor perspective. It found reductions in health, shelter, and justice costs, and the cost of the intervention could be due to the additional costs considered compared to other quasi-experimental studies with comparison group which only considered health care costs.

Similar to the previous review, some studies used a governmental perspective (53, 131, 132, 149, 150), though again, few studies have examined the impact of HF on social assistance and income supplements. Those studies that did include social assistance found that these payments were higher in the HF group (20, 21, 122). As mentioned in the previous review, this reason could be due to the case management services that assisted HF participants with enrolling in income assistance program (19). As well, this literature review found, consistent with the previous review, that while HF does generate cost offsets for participants over a 1–3-year period, they tend to be less than the cost of the intervention (19-21, 53, 130-132, 140, 152). However, the cost of the intervention in the French study was completely offset (122). This exception may be due to differences in public benefits. In France, a monthly housing allowance is provided to citizens from three types of programs (154) and it is widely accessible. The French study included the housing

allowance as a welfare benefit, a category that was higher than for the TAU group (122). This more generous benefit reduces the need for a rent supplement, leaving only case management as the main cost of the intervention – a greater proportion of this cost can then be offset by reductions in healthcare costs. In Canada, monthly housing benefits are much more modest (155), therefore, the cost of the program is higher since it includes the cost of a rent supplement in addition to case management. Spain provides a less generous housing benefit than France as they provide a yearly housing allowance of \in 525 to those renters who hold pensions (156). Denver has an emergency rental assistance program, but the government does not provide a housing benefit (157). These findings highlight the importance of context when evaluating the cost-effectiveness of HF programs.

The two modeling studies gave different results: the French study found the cost of the HF group over 35 years was marginally higher than that of the TAU group while the AHCS Montreal study found HF was cost-saving compared to TAU in 10 years. These studies most likely reached different conclusions due to differences in assumptions that were used to model costs and the country's social assistance programs. In the Montreal study, HF participants were expected to use less of the case management services at a rate of 2.5% decrease per year (139). This method is more conservative than the French modeling study which assumed the cost of the intervention would decrease to 75% in year three, 60% in year four to 50% in year 5 until year 35 (126).

Pre-post only studies generally found that overall costs, including the intervention cost, decreased (131, 132, 141, 142, 145, 149, 150) though, this decrease is most likely due in part to regression to the mean rather than intervention. As the previous review noted, participants enrolled in pre-post studies most likely experienced higher-than-average (for them) service use at the time of recruitment. The French and AHCS publications reported that service use decreased following

study recruitment for the control groups as well (20, 21, 122). However, only the French study reported that the net cost found that the cost saving offset the cost of the intervention (141) while the AHCS study found a cost-offset of 60-90% (131, 132). This variability might be due to the perspective, as the study that found a decrease in net cost considered only costs for services such as in-patient, ED visits, and skilled nursing facilities (141); the other two studies considered additional costs, one used a government perspective (132) and the other considered additional health costs related to mental health (131).

The quality of evidence varied across studies. Pre-post only studies are subject to regression to the mean and thus tend to overestimate the effects of the intervention. In addition, they had mostly small sample sizes (131, 132, 141, 142, 145, 149) and presented concerns with incomplete capture of costs from administrative data (132, 142, 149). Quasi-experimental studies with a comparison group provided more credible evidence as most used propensity score matching or weighting to address potential selection bias (140, 144, 146, 151-153). The certainty of evidence was highest in experimental studies which utilized different methods to address bias or missing data such as allocation concealment and multiple imputation (20, 21, 122). However, some concerns in the Denver and especially the Spanish study were noted due to non-response at recruitment and selection bias from differential follow-up, respectively (130, 143).

Limitations which existed in the previous review remain in this updated literature review. First, all studies, with the exception of two, followed participants for fewer than 3 years. Two pre-post only studies examined HF for a period greater than 3 years (141, 150). As previously mentioned, the modelling studies which projected between 10 years to 35 years suggest that the net cost of HF compared to usual services would be close to zero or even negative (126, 139). However, no study of using an experimental design with a follow-up of more than 3 years has reported on costs.

Second, as in the 2015 review, the way unit costs were derived was generally not described. Third, although most studies used a health care system perspective, the services that were considered varied by study (19). The lack of consistency in services considered most likely contributed to variability in the reported net overall cost of the intervention. Bamberger and Dobbins (2015), for example, included only services categorized as inpatient stays, ED visits, and skilled nursing stays; most studies, however, combined at least some data from other health care services such as outpatient services and prescription drugs (53, 131, 132, 140, 142, 144-146, 149-152). Fourth, this review found more experimental studies (four of the five) that used self-report questionnaires (20, 21, 122, 130) compared to the 2015 review in which only the AHCS study relied on self-report questionnaires (19). Though self-report questionnaires are vulnerable to recall bias, some of the questionnaires used have been previously validated (158, 159) and self-report questionnaires can reflect administrative data with some validity (160). However, as was noted in the previous review, the use of self-report questionnaires may lead to bias due to differential attrition as those who are in poorer health states are more likely to be lost to follow up and TAU participants might be lost due to lack of interest in the study (19). As mentioned previously, quasi-experimental studies tend to use administrative data particularly for those that used health care or Medicare/Medicaid as a perspective (142, 144-146, 151-153). However, some services or visits to health care facilities/providers might not be captured as noted in the previous review (19). For example, Aidala et al. (2014) only included service costs that were publicly funded and shelter costs but no other housing type. As well, Wood et al. (2019) had only collected health care service use from 4 hospitals and mentioned that the health care costs could be underestimated if participants went to other hospitals. In addition, the intervention differed across studies, particularly with regards to the type of housing. The intervention was generally consistent among experimental studies, which

mostly tested scattered-site housing with off-site supports (20, 21, 122, 130, 143). Quasiexperimental studies, however, offered varying degrees of the HF intervention, providing mainly congregate housing (132, 140, 142, 144, 145, 149, 151), except three studies that offered a mix or exclusively scattered-site (131, 152, 153).

Conclusion

The updated literature review suggests that over a two to three-year horizon, HF leads to significant cost offsets that can equal or even exceed the intervention cost, depending on the context. This appears to be true across populations tested so far, with the possible exception of transition-age youth. Modeling studies suggest HF may be cost saving or nearly so in the long run, though additional studies are needed to confirm this. HF remains an effective and relatively inexpensive intervention, but it should not be expected to fully pay for itself, at least in the short run, similar to most health care interventions.

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Figure 1. PRISMA Flow chart



Fable 1.1 Characteristics	; of	experimental	studies
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Pub	Published experimental designs - Methods										
No.	Study and site	Population	Interventions and sample sizes*	Recruitment period and follow-up duration	Perspective of the economic evaluation	Data collection method	Key observations	Measured costs, earnings, and transfers			
1	At Home/Chez Soi (AHCS) Vancouver, BC Winnipeg, MB Toronto, ON Montreal, QC Canada Latimer et al. (2019)	Homeless with mental illness; "moderate needs" as defined in AHCS	Scattered-site apartments plus ICM vs Treatment as usual E: $n = 689$ C: $n = 509$	October 2009 – June 2011 24 months (21 for some participants enrolled later at some sites)	Modified societal (government benefits counted as a cost, employment earnings subtracted)	Retrospective questionnaires, 3- or 6-month intervals depending on measure	Adaptive randomization algorithm used with allocation concealment. Missing data addressed using multiple imputation	Health and social services: ED, hospitalizations (psychiatric and physical), visits to and by community providers, outpatient visits, visits to day centres, shelters, rehabilitation centres, etc. Justice services: police contacts, arrests, court appearances, incarcerations. Welfare and disability payments. Employment earnings.			
2	AHCS Vancouver, BC Winnipeg, MB	Homeless with mental illness; "high needs" as defined in	Scattered-site apartments plus ACT vs Treatment as	Same as above.	Same as above.	Same as above.	Adaptive randomization algorithm used with allocation	Same as above.			

		Montreal,		E: <i>n</i> = 469					
		QC		C: $n = 481$				Missing data	
		Moncton,						addressed	
		NB						using multiple	
		Canada						imputation	
								1	
		Latimer E							
		et al. (2020)							
F	3	Un chez-soi	Homeless	Scattered-site	August 2011	Modified	Retrospective	A computer-	Health services:
	5	d'abord	with mental	anartments	- April 2014	societal	questionnaires	generated	ED visits
		Marseille	illness	nlus	11pm 2011	(similar to	6-month	randomized	hospital
		Toulouse	"high needs"	ACT vs	21 months	above	intervals	list is created	admissions and
		Doris	defined as in	Treatment as	24 monuis	without	inter vais	using a	length of stay
				Liquol		considering		using a	(public and
		Eronaa	AIICS	-252		considering		blook design	(public allu
		France		E: $n = 555$		employment		block design	private,
		T . 1 1 /		C: $n = 350$		earnings)			psychiatric and
		l inland et						Missing data	medical), nursing
		al. (2020)						Missing data	and long-term
								addressed	care facilities
								using multiple	(public and
								imputation	private), health
									rehabilitation
									residential
									programs,
									therapeutic
									apartments and
									harm reduction
									centers, physician
									consultations.
									Social services:
									Emergency
									shelters,
									transitional
									shelters, housing
									benefits.

								Justice services:
								Court
								appearances,
								days in detention
								and penitentiary
								structures.
								Welfare benefits.
4	Denver	People	Mix of	January 2016	Not stated	Combination	Potential	Housing
	Supportive	experiencing	scattered and	– December	but akin to	of	nonresponse	assistance
	Housing	homelessness	congregate	2017	governmental	administrative	bias as only	Health and social
	Social	who had 8 or	housing plus		-	data	79% of the	services: office-
	Impact Bond	more arrests	ACT with	2 years		(Medicaid,	363	based care, ED
	Initiative	over 3	1:13			Colorado	individuals	visits, inpatient
		consecutive	staff:client			Access,	assigned to	care, ambulance
	Denver	years, at least	ratio (2			Denver Health	the	trips, other
	CO	3 of which	different			and Hospital	experimental	services;
	USA	while	providers) vs			Authority) and	group were	supportive
		homeless	usual care in			direct data	located,	housing services,
			the			collection with	engaged and	emergency
	Cunningham		community			local service	housed.	shelter, short-
	et al. (2021);		E: <i>n</i> = 363			providers.		term
	Gillespie et		C: <i>n</i> = 361					detoxification
	al. (2021)						The treatment	facility visits, and
							and control	911 and
							groups were	emergency
							created based	medical services
							on their	(EMS) responses.
							random	Justice services:
							number and	police contacts
							the number of	and arrests, court
							individuals in	cases,
							that matched	
							by entry type.	
5	Spain	People	Scattered-site	August	Not stated	Retrospective	Proportional	Specific costs:
	_	experiencing	apartments	2014-2015		questionnaires	stratified	Accommodation,

	Martínez- Cantos, Martín- Fernández. (2023)	both homelessness and mental illness and/or addictions or disabilities	with ICM vs Treatment as Usual E: <i>n</i> = 152 C: <i>n</i> = 284	18 months		at baseline, 6, 12 and 18 months	random procedure, taking gender into account. Large differential attrition (24% for experimental group vs 50% for the control group)	food, cleaning, care and support services, addiction treatment, indirect costs, intervention Non-homeless specific costs: Health services, psychiatric services, administrative fines, legal problems.
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* C: control group; E: experimental group; ED: Emergency Department; ICM: Intensive Case Management; ACT: Assertive Community Treatment.

Studies w	Studies with comparison group									
No.	Study and site	Population	Interventions and sample sizes	Observation period	Key observations	Stated perspective measured costs, earnings, and transfers				
6*	Frequent Users Service Enhancement 'FUSE' Initiative New York City, NY USA Aidala et al. (2014)	People with four jail and four shelter stays over the five years prior to admission.	Single-site apartment with ICM vs those not in the FUSE program E: $n = 60$ C: $n = 70$	24 months, follow-up every 6 months	Used propensity score to match control and intervention groups.	Public payor and societal (i.e., all housing costs included regardless of who paid for them). Health, justice, and social service. Physical and Mental Health and Alcohol and Other Drugs Services: Ambulance ride, ER visits (including psychiatric and substance/alcohol related), hospital day for physical health, psychiatric, hospital day, inpatient day for alcohol and other substance, substance treatment day, substance residential treatment day; Justice: Jail stay; social: shelter stay;				

 Table 1.2 Study characteristics of quasi-experimental studies published by design type

7	California,	Transition-age	Permanent	1 year pre	Used propensity score	Medicaid: Inpatient,
	USA	youths with	Supportive	1 year post	to match control and	crisis and residential
		severe mental	Housing with		intervention groups.	services (including
	Gilmer (2016)	illness	differing fidelity			services provided by
			to Pathways HF		Fidelity of the program	crisis residential
			model (mix of		was graded from low to	facilities, psychiatric
			single-site and		high using the self-	health facilities,
			scattered-site		report Housing First	residential facilities,
			housing) vs TAU		Fidelity	ED visits, and
					Survey. The top 20%	institutions of mental
			E: <i>n</i> = 2,609		of programs were	disease), and mental
			C: <i>n</i> = 2,609		designated as high	health outpatient
					fidelity and the bottom	(including assessment,
					20% were designated.	medication
					as low fidelity: the	management,
					remaining were mid-	rehabilitation, and
					fidelity.	therapy).
					The intervention was	
					not consistent across	
					participants.	
					No significant	
					differences	
					in demographic or	
					clinical characteristics	
					between youths in	
					PSH programs and	
					youths in the	
					propensity score-	
					matched	
					control group.	
8	New York City,	Adults	Single-site	2 years pre	Those in the	Medicaid: Outpatient
	NY	experiencing	apartments with	2 years post	experimental group	care, inpatient care,
	USA	either 1) chronic	on-site support vs		were considered part of	emergency department

	Lim et al., (2018)	homelessness and serious mental illness or, 2) dual diagnosis of mental ill-ness and a substance use disorder	those not in any supported housing program E: <i>n</i> = 737 C: <i>n</i> = 2090		the program if they were in the program for more than 7 days. For the control group, they were considered unplace if they had not been placed by the program for 2 years Costs of services were potentially underestimated, though the authors argued it might only have a small impact on results. Propensity score matching was	visits, and prescription drugs. Other costs consisted of health agencies and personal care, and residential care.
9	Pittsburgh, PA USA Hollander et al., (2021)	Adults (21 and above) experiencing or at risk of homelessness experiencing mental illness or substance use disorder	Permanent Supportive Housing (single- site and scattered- site) vs those not in Permanent support housing E: $n = 1226$ C: $n = 970$	7-15 months pre 18 months post (Total: 3 years)	Unable to obtain housing data for Philadelphia and 12 other counties that use separate HMIS systems. Experimental participants were considered eligible if they were in PSH for 180 days. Used propensity score matching. Constructed a propensity score that	Medicaid: 3 major service categories behavioral health, physical health, and pharmacy spending.

					summarized individuals' propensity to receive PSH as a function of these characteristics and matched each PSH recipient to up to four comparison individuals within the same propensity score quantile (of 40 quantiles).	
10	New Jersey, USA DeLia et al. (2021)	Adults experiencing homelessness	Permanent Supportive Housing (single- site) vs those not in Permanent support housing E: $n = 1442$ C: $n = 6064$	2-3 years pre 2-3 years post	Matching was conducted (5 participants in control group for each experimental participant)	Medicaid: ED visits, inpatient admissions, primary care visits, and pharmacy spending.
11	Louisville, KY USA Dobbins et al. (2021)	People experiencing homelessness and severe mental illness	Permanent supportive housing (unknown if single-site or scattered-site) vs Treatment First E: $n = 91$ C: $n = 19$	1 year pre 1 year post	Very small sample size (especially the control group) Control group could have access to some components of HF (contamination bias) Low service error due to participants in control group being in	Not stated Govermental: emergency department, state psychiatric facility, correctional facilities, and total inpatient and outpatient visits.

					supported housing for longer periods. Costs might be underestimated as some participants received medical services in jail. Cost of stay per day in jail was included to mitigate this.	
12	Santa Monica, CA USA Hunter et al. (2021) (report)	High-cost users experiencing homelessness with high needs	PSH with ICM (scattered-site) vs not enrolled in PSH E: $n = 162$ C: $n = 354$	6 months pre 6 months post	20% of the control group was offered housing services but declined. This potentially introduces some selection bias as these individuals might be different from those in the experimental group. Sample size was increased, and the analysis conducted with and without these individual. The authors found the results were not affected by excluding these individuals. Propensity score weighting was used. Authors prorated the service utilization and associated cost data for	Healthcare: ED visits, in-patient care, out- patient care, custodial, emergent, home care, pharmacy, temporary lodging and other.

Pre-post	studies with no co	mparison group			members of the treatment group who died during the follow-up period (n = 12).	
13	San Francisco, CA USA Bamberger and Dobbins (2015)	Seniors experiencing homelessness	Permanent supportive housing (single site) with case management (off- site) and on-site support services E: n = 51	1 year pre 7 years post	Lack of costs in analysis, only three unit costs considered 12 participants were placed from skilled nursing facility (SNF) while 39 were recruited from community referral. All were considered to be experiencing homelessness. Noticeable differences between those who were referred from community vs those from SNF on all outcomes regarding costs. Larger percentage of those placed from SNF left the PSH due to death or returning to SNF.	Medi-Cal (California's Medicaid program) Emergency room encounter, night spent in an inpatient hospital ward; and night spent in a SNF

14	Portland, OR	People	PSH (single-site	2 years pre	Prioritize vulnerable	Medicaid: ED visits,
	USA	experiencing	housing) with on-	2 years post	individuals (possible	primary care visits,
	Wright at al	modically	site support		selection bias).	boolth visite ato
	(2016)	vulnerable	$F \cdot n - 58$		Only 58/89 participants	ileanii visits, etc.
	(2010)	vullerable	L. $n = 50$		had Medicaid data	
					(though the authors	
					discuss that the	
					participants were	
					comparable (those with	
					Medicaid data vs those	
					without))	
15	Brisbane,	People	PSH (single-site)	1 year pre	Recruited those who	Not stated
	Queensland	experiencing	with on-site	1 year post	had been in the	
	Australia	homelessness and	supports		program for at least 12	Health and social
		mental illness			months	services: ED, hospital
	Parsell et al.,		E: <i>n</i> = 41			admitted patients,
	(2016)				61 participants were	ambulance, mental
					eligible, but only 41	health, and
					gave consent on their	homelessness services;
					data while six only	Justice: police, prison,
					gave partial consent.	probation, parole, and
					Possible non-response	courts.
					bias.	
					Complete service data	
					was found in only 35	
1.6	D				participants.	
16	Doorway	People	HF (scattered-	/ months pre		Not stated
	program*	experiencing or at	site) with	3 years post		Concert to a life or miner
	Ivielbourne,	risk of	community-based			General nealth services
	Australia	experiencing	supports			and mental health
	Devit et al	nomelessness	E			services, ED Visits.
	Dunt, et al.	with mental	E: $n = 55$			
	(2017)	illness (already				

		receiving case management and disability payments)				
17	Alaska HF AK, USA Driscoll et al. (2018)	People experiencing homelessness and recently discharged from hospital	PSH (single-site buildings) with community-based supports (on-site at one and off-site at another) E1: $n = 23$ E2: $n = 31$ ***	1 year pre 2 years post	Heterogeneity in the supports offered (on- site vs off-site and one site with one case manager per tenant while the other does not have a case manager for each tenant). Administrative data and information from service providers outside of the intervention (e.g. police officers, fire department, community service patrol, etc). One site had three hospitals with administrative data while the other site only had one	Not stated Healthcare services: ED visits, inpatient days, outpatient clinic visits. Justice services: police and fire department encounters, community service patrol pick-ups and nights spent in the sleep off center, shelter nights, and nights spent instate department of corrections facilities.
18	Perth, WA Australia Wood, et al. (2019)	People experiencing homelessness and recently discharged from hospital	HF with community-based supports (unclear if single-site or scattered-site) E: $n = 44$	1 year pre 1 year post	Only four EMHS hospitals. At least 30% of 50L50H clients are presenting at other hospital. Likely	Healthcare: ED presentations, hospital admissions and outpatient service.

					healthcare cost is	
					underestimated	
					unuerestimateu.	
19**	HF Calgary:	People	PSH, single-site	4 years	Information from 25	Not stated
	Calgary, AB	experiencing	and scattered-site		programs in Calgary	
	Canada	homelessness split	with case		which offer different	Healthcare: hospital
		between high-	management,		HF services.	visits, ER visits,
	Jadidzadeh. et	needs and	transitional			Justice: police contacts.
	al. (2020)	moderate-needs	housing		Self-report was	arrests, court
			8		combined with	appearances, police
			E: $n = 2222$		information from case	cell. detention centres.
					managers to increase	and prison.
					certainty	and hussen
					containty.	
					Uses unit costs that	
					correspond to stay for	
					people experiencing	
					homelessness rather	
					than the public.	
					Estimated costs for	
					justice system using a	
					warrant cycle to	
					average cost for a	
					police interaction.	
					562 participants were	
					excluded for no follow-	
					up assessment (possible	
					introduction of bias).	
					Used two models to	
					estimate cost savings	
					(fixed-effects OLS and	

		fixed-effects negative	
		binomial distribution)	

* Prospective study, jail and municipal shelter use was collected through administrative data. Health service and housing costs were collected from self-report questionnaires.

**Used self-report questionnaires and was a prospective study.

***E1 and E2 designate two different sites.

Table 2.1	Results	of ex	perimental	studies
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Publis	Published experimental designs - Results			
No.	Study	ICER	Other results	
1	AHCS - Moderate-	CAD 56.08	Cost of the intervention was offset by 46%.	
	needs	(95% CI: 29.55,		
	Canada	84.78) per	After 2 years, HF participants had statistically significant annualized cost reductions of	
		additional day	CAD 1,000 or more in shelters (CAD 2,627 (95% CI: 2,079, 3,232)), substance use	
	Latimer et al.	of stable	treatment (CAD 1,148 (95% CI: 638, 1,658)), supportive housing (CAD 1,861 (95% CI:	
	(2019)	housing	1,222, 2,540)), and ambulatory visits (CAD 2,375 (95% CI: 1,523, 3,226)).	
			Annualized total costs per person after baseline: E: CAD 48.716 (95% CI: 46.593.	
			51.072); C: CAD 40.849 (95% CI: 38.374, 43.538); Difference: CAD 7.868 (95% CI:	
			4,409 to 11,405)	
2	AHCS – High	CAD 41.73	Cost of the intervention was offset by 69%.	
	needs	(95% CI: 1.96,		
	Canada	83.70) per	After 2 years, HF participants had statistically significant annualized cost reductions of	
		additional day	CAD 1,000 or more in shelters (CAD 1,943 (95% CI: 1,431, 2,554)), supportive housing	
	Latimer et al.	of stable	(CAD 1,793 (95% CI: 1,249, 2,437)), ambulatory visits (CAD 4,759 (95% CI: 3,233,	
	(2020)	housing	6,495)), and incarcerations (CAD 1,485 (95% CI: 73, 3,001)).	
			Annualized total costs per person after baseline: E: CAD 62.395 (95% CI: 58.843.	
			65,897); C: CAD 56,084 (95% CI: 51,501, 60,828); Difference: CAD 6,311 (95% CI:	
			309, 12,350)	
3	Un chez soi	NA	Cost of the intervention was offset by 100%.	
	d'abord			
	France		HF participants had significantly lower annualized healthcare costs (18,116 €) and	
			residential services (8,276 €) but had significantly higher welfare benefits costs (1,399	
	Tinland et al.,		€) compared to the control group.	
	(2020)			
			Annualized total costs per person after baseline: E: 76,808 €; C: 76,825 €; Difference:	
			17€.	
4	Denver, CO	NA	Cost of the intervention was offset by 57% for E1 and 44% for E2.	
	Supportive Housing			

	Social Impact Bond		Significant average cost reductions of USD 1,000 or more in jail days (USD 2,386) and
	Initiative		ambulance (USD 1,662). Trend (p<0.10) towards higher inpatient costs (USD 2,106).
			Excluding intervention costs of USD 12,078 for E1 and USD 15,484 for E2, overall
	Cunningham et al.		annualized per person costs were USD 6,876 lower for HF than control group.
	(2021), Gillespie et		
	al. (2021)		Annualized total costs per person after baseline: E1: USD 30,746; E2: USD 34,152; C:
			USD 25,544. Differences: E1: USD 5,202; E2: USD 8,608.
5	Spain	EUR 46.72	Cost of the intervention was offset by about 43%. ¹
		(95% CI: 48.1,	
	Martínez-Cantos,	795.5) per night	Average cost reductions of 1000 € or more per year were observed for care and support
	Martín-Fernández.	of homelessness	services (2,487 €) and psychiatric care services (1,531 €). (Differences not tested.)
	(2023)	that is reduced.	
			Annualized total costs per person after baseline:
			E: 20,480 €; C: 13,894 €. Difference: 6,586 €.

¹ The cost of the intervention was about $671.53 \notin$ (accommodation, obtained by subtracting comparison from experimental group monthly average cost) plus $283.90 \notin$ (support services), for a total of $955.43 \notin$ per month or $11,465 \notin$ per year.

Table 2.2 Results of quasi-experimental studies

No.	Study	Results
6	Frequent Users Service	Total cost Pre:
	Enhancement	E: USD 38,351
	'FUSE' Initiative	C: USD 38,598
	New York City, NY	Total cost Post:
	USA	E: USD 9,143
		C: USD 25,955
	Aidala et al. (2014)	
		Difference between E (HF) and C group is USD 16,812, offsetting cost of intervention by
		66.8% (public payor) or 61.4% (societal) depending on the perspective.
7	California,	For the PSH group, costs for the following categories were higher than TAU: inpatient
	USA	(increased by USD 1,088), crisis and residential services (increased by USD 1,271), and
		mental health outpatient (increased by USD 10,979).
	Gilmer (2016)	
		Difference in differences found that the total service costs were significantly higher, by
		USD13,337, for youth in PSH programs compared with the control group. Thus, no cost
		offsets were observed in this study.
		E: USD 27,576
		C: USD 13,208
		Patients in high-fidelity programs had the largest increase in costs, followed by clients in
		mid- and low fidelity programs (significantly difference between groups).
8	New York City, NY	Difference between E (PSH) and C group (TAU)
	USA	18 -USD 9,526 (95% CI: -\$19,038, -\$2,003)).
	Lim et al., (2018)	Significant cost reductions in inpatient care (USD 5,864 (95% CI: 123, 12,251)), ED visits
		(USD 318 (95% CI: 26, 598)), prescription drugs (USD 2,014 (95% CI: 998, 3,931)) for
		HF compared to TAU.
9	Pittsburgh, PA	A significant difference in Medicare costs
	USA	between E (PSH) and C group of USD 145/month.

	Hollander et al., (2021)	A reduction of USD 145/month (95% CI: 3, 289) for PSH group.
		HF group had significantly lower costs for physical (USD 73/month (95% CI: 13, 133)) and behavioral service (USD 119/month (95% CI: 48, 191)) compared to the control group. Cost saving came from reduction in costs for residential behavioral health (USD 64/month (95% CI: 34, 95)) and inpatient non-behavioral health services (USD 89 (95% CI: 39, 139))
10	New Jersey, USA DeLia et al. (2021)	The experimental group had USD 31.08 less spending in ED visits per person per quarter relative to the control group. The experimental group also spent USD 175.61 more in pharmacy cost per person per quarter compared to the control group.
		No statistically significant difference in other costs.
		The experimental group total cost was USD 13.74 (95% CI: -220, 247) higher compared to the control group, but not significantly different.
11	Louisville, KY USA	Significant cost reductions in emergency room (USD 1,522,164.35) and inpatient costs (USD 779,366.44) for HF group between pre and post timepoints.
	Dobbins et al. (2021)	1 year prior to HF E = USD 55,860 C = USD 12,848
		6 months after HF
		E = USD 26,126
		C = USD 3,058
		Costs by service and total costs were not significantly different.
12	Santa Monica, CA	Health care cost:
	USA	6 months prior to HF $E = USD 7.407.755$
	Hunter et al. (2021)	C = USD 3,789,000
		6 months after HF
		E = USD 4,486,025
		C = USD 2,170,428

		No significant difference between groups.
		For the experimental group, there was a cost reduction of USD 3,006 per person per
		month and the comparison group had a similar cost reduction of USD 3,057 per person per month.
Pre-post studies	with no comparison group	
13	San Francisco, CA	Pre: USD 1,717,430
	Untied States	Post: USD 1,186,002
	Bamberger and Dobbins	Overall cost saving over 7 years was estimated as USD 9.2 million. This cost saving fully
	(2015)	offsets the cost of the intervention which is estimated for all participants as USD 8.5
		million.
14	Portland, OR	Per member per month of coverage costs
	US	$Pre-HF \cos t = USD \ 1,626$
		Post-HF cost = USD 995
		Total actimated aget serving in 1 years USD 505 002
		10 tal estimated cost saving in 1 year = 0.5D 505,992
		Significant reductions in FD (USD 155/month) inpatient behavioral care (USD
		51/month) outpatient primary care (USD 38/month) outpatient lab testing (USD
	Wright et al. (2016)	86/month), and outpatient specialty care (USD 53/month) costs.
15	Brisbane, QLD	Pre-HF cost = AUD 1.976.916
	Australia	Post-HF cost = AUD $852,314$
	Parsell et al. (2016)	After including the cost of the intervention, costs decrease by AUD 13,100 offsetting 90%
		of the cost of the intervention (AUD 14,329).
16	Doorway program	Costs for mental health services decreased by AUD 1882, ED costs also decreased by
	Melbourne,	AUD 349 per participant per year.
	Australia	
	D (1 (2017)	Costs decrease by AUD 11,033 per participant per year, offsetting 61% of the total cost of
17	Dunt, et al. (2017)	the intervention (AUD 18,0/3)
1/	Alaska HF	I otal costs of emergency and legal services
		$Pre-HF \cos t = USD 225,428$
	US	$Post-HF \cos t = USD \delta 1,6/0$

	Driscoll et al. (2018)	Total costs of health care services Pre-HF cost = USD 1,427,022 Post-HF cost = USD 2,117,490
18	Perth,	$Pre-HF \cos t = AUD 745,866$
	WA	Post-HF cost = AUD 341.838
	Australia	
	Australia	Significant cost reductions were found for FD visits in patient services and total health
	Wood at al. (2010)	costs
	Wood et al. (2019)	
		Overall decrease in health service costs of AUD 404,028
19	HF Calgary:	Hospitalization visits:
	Calgary, AB	Total cost saving for 48-month period when using negative binomial distribution: CAD
	Canada	37.233
	Iadidzadeh et al. (2020)	Total cost saving when using Least Squares Regression:
		CAD 50.028
		CAD 30,320
		Overall cost saving for 48-month period when using negative binomial distribution: CAD
		1,963
		Overall cost saving for 48-month period when using Least Squares Regression: CAD
		2,086
		Police Time:
		Overall cost saving for 48-month period when using negative binomial distribution: CAD
		174,048
		Overall cost saving for 48-month period when using Least Squares Regression: CAD
		144.073
		Total costs:
		Annual saving when using negative binomial distribution: CAD 53 311
		Annual saving when using Least Squares Regression: CAD 49 272
		Trinual saving when using Least Squares Regression. CAD 47,272
4. Methods

This section and subsequent sections address the second objective of this thesis, analyzing the cost-effectiveness of HF at 6 months prior to the 43-48 month interview.

4.1 Setting

Montreal was one of the five cities where AHCS was conducted. Data collection for the original study in Montreal was from October 2009 to May 2013 and data for the extension study were collected between February 2014 and October 2015. During the original study, data were collected every three months (23) while the extension study only collected data once for each participant, approximately four years after study entry.

4.2 Participants

Participants were recruited in Montreal through referrals from community service providers from various areas including homeless shelters, drop-in centers, hospitals, community mental health teams, homeless outreach programs, and criminal justice programs, as well as self-referrals and outreach (115). Participants of the original study were required to meet the following inclusion criteria to qualify: (1) legal age of majority (18 in Québec); (2) experiencing absolute homelessness or being precariously housed; and (3) presence of a mental illness, with or without a concurrent substance use disorder, as evaluated using the Mini International Neuropsychiatric Interview (MINI). Participants were excluded if they received either ICM or ACT as these were part of the intervention.

Participants meeting these guidelines were stratified into HN and MN groups. Participants were considered HN if they had: 1) an overall score of 62 or less on the Multnomah Community Ability Scale (MCAS); 2) a primary or secondary diagnosis of either bipolar or psychotic disorder from the MINI; and 3) one of the following: a) diagnosis of substance use disorder; b) 2 or more hospitalizations due to mental illness within one year in the past 5 years; or c) one or more arrests or incarcerations within the previous 6 months. Participants who did not meet these criteria were considered MN.

4.3 Randomization

Participants were randomized via a computer algorithm with bias-reducing allocation (23). This adaptive randomization method allowed for the groups to be balanced on key variables expected to affect the outcome (23). For the HN group, participants were assigned to either 1) HF with ACT,

or 2) Treatment as Usual (TAU). For the MN group, participants were assigned to either 1) HF with Intensive Case Management (ICM) or 2) TAU (115). Participants assigned to TAU could receive existing services related to housing and community supports outside of HF (9, 115).

4.4 Intervention

The intervention group originally received scattered-site supported housing with mobile, off-site services (115) and support through a case manager. The housing team helped locate apartments for participants in the HF groups for which they were expected to pay 25-30% of their income (depending on whether heating of the apartment was included in the rent), the rest of the rent coming from the project. In Montreal, ICM services were provided by an institutional provider, Centre de santé et de services sociaux – Jeanne Mance (JM) or a community-based non-profit, Diogène (DIOG). Participants were assigned to JM or DIOG randomly. No meaningful difference between either group were found, however, so both groups were combined for the purposes of this study. A separate team, common to all the HF participants (HN and both MN groups) found the apartments, provided the rent supplements, and managed relationships with landlords.

4.5 Measures

Using methods similar to those used for the earlier studies, the costs of health, social, and justice services per person during the 6 months prior to the 48-month interview were estimated using three retrospective questionnaires: the Health Services and Justice Services Use Inventory (HSJSU), the Residential Time-Line Follow-Back (RTLFB) and the Vocational Time-Line Follow-Back (VTLFB) (9). The HSJSU was administered every 6 months and captures ambulatory health and social non-overnight services including hospital outpatient visits, contacts with case managers in the community, and contacts with police. The RTLFB reconstructed the types of locations where the participant spent each night since the previous interview. The VTLFB focused on income and employment activities. Both the RTLFB and VTLFB were administered every 3 months but at the 4-year interview, they captured the previous 6 months.

4.6 Economic Perspective

A modified societal perspective was adopted, as in previous AHCS economic analyses. This perspective includes costs related to health, social and justice services but adds welfare and disabilities as these payments primarily cover the basic needs of homeless individuals. These payments can be considered as an alternative form of support, similar to shelters and food banks. Including social assistance and disability benefits as costs, while excluding participants' out-of-

pocket payments for food or shelter to prevent double counting, and subtracting any earned income, can also be seen as being consistent with a social cost impact analysis (86).

4.7 Costing

All unit costs were taken from the original study (9) and then inflated to 2022 dollars using the Montreal-specific all-item consumer price index (161). Costs were then calculated using the frequencies obtained from the three questionnaires (HSJSU, RTLFB, VTLFB) which were then multiplied by unit costs (e.g., cost for one night in the psychiatry department of a general hospital). 4.8 Outcomes

The primary outcome of this extension study was number of days of stable housing during the 6 months prior to the 43-48-month interview. The study defined this as living in one's own room, apartment, or house, or with family, with an expected duration of residence of 6 months or more or tenancy rights (23). An alternative measure of the outcome of housing stability was days in apartment which was defined as days spent in a private apartment, including but not limited to a HF apartment from the original study. This secondary outcome was also considered since days of stable housing includes situations of hidden homelessness as described in the Canadian homelessness classification (24).

4.9 Discounting

A 1.5% discount rate was used to discount all costs and days of stable housing following the first year of the study as recommended by Canadian Agency for Drugs and Technologies in Health (162). This affected the first 2 years of follow-up which were used as predictor variables in the multiple imputation (see below).

4.10 Statistical Analysis

Missing data for employed and welfare or disability incomes, costs of residential stays, and cost of health, social and justice service in both the original 24-month and extension study occurred due to participant non-response or improbable responses on specific items. For the residential data, certain residential types were deterministically imputed with 0 values due to a high number of 0 values (over 95%) to reduce collinearity. The mice package in R was used to perform multiple imputation (25 iterations, 5 imputed datasets) to impute missing components. The mice package imputed all continuous variables using predictive mean matching and the multiple imputation model included the item-level longitudinal outcomes at baseline, 3, 6, 9, 12, 15, 18, 21, 24, and

43-48 months, treatment group, and auxiliary variables associated with missingness (i.e., age at enrollment, gender, marital status, diagnosis, education, and racial and ethnic identities).

A per protocol analysis was conducted. Means and standard deviations were then calculated for each group over the 43-48 month time period. In earlier analyses of At Home/Chez Soi data, discrepancies were noted between self-reported duration and frequencies of visits of At Home/Chez Soi providers in Montreal, and actual frequencies and visit durations recorded by the ACT and ICM teams. Adjustment factors were derived to correct for these discrepancies (9). These adjustment factors were applied to all community-based support provider visits in earlier economic analyses (9, 20, 21) and were applied again in the present analysis.

Bootstrapping

Bootstrapping was conducted to estimate the uncertainty around the incremental cost-effectiveness ratio (ICER). The ICER was calculated by taking the difference in costs between the HF and TAU groups and dividing it by the difference in the number of days of stable housing between the two groups. The bootstrapping was combined with multiple imputation: following each bootstrap resampling, the missing values of that sample were then imputed (10 iterations) using 5 imputed datasets as previously done in the original study (20, 21). The number of iterations was chosen to be a somewhat lower number due to the computational burden of combining iteration with bootstrapping. The means and bias-corrected accelerated confidence intervals of the ICERs were estimated using 1000 bootstrapped resamples and plotted on the cost-effectiveness plane. Using this information, the cost-effectiveness acceptability curve (CEAC) was plotted to determine the probability of the intervention being cost-effective at different willingness to pay thresholds. The point estimate for each bootstrapped sample was computed by taking the average of each of the 5 point estimates resulting from the 5 imputed datasets (163).

Sensitivity Analyses

A one-way sensitivity analysis was used to determine if the ICER remains robust when there are changes in a specific variable. Variation in cost of HF apartments was tested using an increase of 10% to 20%. This variable was picked as rent has seen high increases across Canada over the past few years (164, 165).

Net Benefit Regression

A net-benefit approach was used to describe further the effects of sampling uncertainty (166). The sample excluding the 10 individuals initially assigned to TAU who were receiving HF services

was used. The intervention is considered cost-effective if $\lambda\mu\Delta E - \mu\Delta C > 0$ with λ being the threshold ratio (in dollars per additional day of stable housing or day in apartment) above which the decision-maker no longer finds the intervention cost-effective; $\mu\Delta E$, the mean difference in effectiveness between the HF and TAU groups; and $\mu\Delta C$, the mean difference in costs. We then employed linear regression, using values of λ ranging from \$0 to \$100, to estimate the relationship between each individual's net monetary benefit and several variables selected as in the previous AHCS papers (20, 21). These variables included initial group assignment, controlling for the same baseline covariates as in a previous analysis that used costs over the first two years as dependent variable: sex, age, diagnosis of a psychotic disorder, alcohol abuse or dependence at baseline, substance abuse or dependence at baseline, longest prior period of homelessness (years), community functioning score (Multnomah Community Ability Scale), two or more psychiatric hospital stays in 1 of 5 years before baseline and one or more arrests 6 months prior to baseline (9). We also included month of recruitment (0 representing the month that the first participant was recruited, i.e., October 2009) since we expect that those who experience the intervention longer – those who were recruited earlier – benefitted more from the intervention than those recruited later in the study. The Rubin rule was used to derive means, standard errors, and 95% confidence intervals (163).

4.11 Ethics approval

Ethics approval for the Montreal site of the AHCS study was obtained from the Research Ethics Board of the Douglas Mental Health University Institute.

5. Results

5.1 Sample Baseline Characteristics

A total of 362 participants (78% of the original sample) took part in the extension study. To address potential contamination bias, ten TAU participants (eight in the HN group and two in the MN group) were removed because they had received ACT or ICM services during the 6 months prior to the 43-48-month interview. Two participants were also removed due to incomplete residential data and one MN HF participant was removed for not using any HF services throughout the entire study, leaving 349 participants. Baseline descriptive characteristics of the remaining Montreal AHCS participants for the HN group at baseline and at 43-48 month with group assignment can be found in Table 1.a, corresponding information for the MN group can be found in Table 1.b. The 48-month sample similarly to the baseline sample tended to identify as single or divorced (99%), male (67%), and non-ethnic racial identity (87%). No significant differences in descriptive characteristics were detected between baseline and 48-months group for either HF or TAU pairs nor were there differences between the HF groups and TAU groups at 48 months at either need level.

Attrition was non-differential between the treatment groups and TAU groups prior to and following the removal of the ten TAU participants. To address potential selection bias from removing the ten TAU participants, the probability p of not being among the ten TAU participants who received the intervention, given their baseline characteristics, was estimated using a logistic regression model. All participants were weighted by 1/p, then the analysis was performed using the sample that excluded the ten TAU participants. The ten TAU participants were found to have lower MCAS scores compared to the remaining sample, thus the weighting controlled for this variable, and the weighting factor was included in the regression. The weighting did not consider the three participants removed for other reasons (described above).

At 43-48 months, in the HF HN group, 17.7% of participants received only rent supplements, the same percentage received only ACT, and the same percentage received both services. Corresponding percentages for MN participants were 34.6%, 7.1%, and 25.6%.

5.2 Costs of health, social and justice services, and of social assistance net of earned income at 43-48 months

Tables 2.a (HN) and 2.b (MN) show the costs incurred by group assignment for each cost category and total. Among HN participants, a significant difference was found for annual cost in police cell with the HF with ACT group having a lower cost compared to the TAU group (d = -\$86.60, 95%CI = -169.07, -3.52). Prior to including the cost of the intervention, the HF with ACT group had somewhat lower annual costs (M = \$62,953.09, (95% CI: \$42,000, \$77,400)) than TAU (M = \$67,447.75, (\$45,000, \$84,900)) but the difference is not statistically significant. After including the cost of the intervention, the HF with ACT group (M = \$71,859.02, (95% CI: \$52,300, \$83,900)) had higher average total annual cost than TAU, though the difference was still not significantly different. For MN participants, significant differences were found for annual costs in supportive housing (d = -\$4,105.38,95% CI = -7,407.46,-803.30) and drop-in center (d = -\$1,585.16,95%CI = -2,735.47, -434.85) with lower costs for the HF with ICM group compared to the TAU group. Prior to including the cost of the intervention, the HF with ICM group had lower annual costs (M = \$34,653.00, (95% CI: \$22,400, \$36,800)) compared to the TAU group (M = \$44,301.37, (95%) CI: \$33,400, \$48,800)), though not significantly different. After including the cost of the intervention, the HF with ICM group annual costs were still lower (M = \$42,893.74, (95% CI: \$32,900, \$44,600)) than the TAU group, but not significantly different. Figure A1 (in the appendix) shows the boxplot distributions of the annualized cost per participant by group assignment during the 43-48-month interval. The boxplots show that costs HF group participants tended to overlap with the corresponding TAU groups, consistent with the absence of significant differences between annualized costs after including the cost of the intervention (although as seen in Tables 2.a and 2.b, the HF with ICM group had slightly lower annualized costs compared to the TAU group for the MN group). Table 3 shows the total annualized cost and outcomes by group with the Incremental Cost-effectiveness Ratios (ICERs). When days of stable housing was used as the measure of effectiveness, the HN groups were similar at 43-48 months post-randomization (HF with ACT: M = 200.45 (95% CI: 155, 237); TAU: M = 195.40 (95% CI: 151, 236)). In contrast, the HF with ICM groups in the MN group had significantly more days of stable housing (M =273.60, (95% CI: 253, 293)) than the TAU group (M = 225.33, (95% CI: 191, 259), p = .03). When effectiveness was measured as days in an apartment, in the HN group, the HF with ACT group had a significantly higher average (M =166.32, (95% CI: 120, 198)) compared to the TAU group (M

= 84.00, (95% CI: 51.8, 133), p = .00). Among MN participants, the HF with ICM group (M = 237.47, (95% CI: 213, 262)) had significantly more days in an apartment than the TAU group (M = 107.49, (95% CI: 71.5, 137), p =.00). The ICER for the HN group was estimated as \$872.58 per additional day of stable housing (95% CI: undefined, \$3150)¹; for the MN group, HF with ICM was on average both more effective, and less costly than TAU, and thus dominant (95% CI: undefined, \$334). When days in apartment was used as the measure of effectiveness, the ICER for the HN group decreased to \$53.58 per additional day in an apartment (95% CI: undefined, \$997) while for the MN group, HF remained dominant (95% CI: undefined, \$66.2). Costs, outcomes, and ICERs were recalculated with the ten TAU participants that had been excluded: the results were qualitatively similar.

5.3 Bootstrapping of the ICER and Cost effectiveness Acceptability Curve

Figures A2.a (HN) and A2.b (MN) (appendix) shows 1000 bootstrap replicates with 10 imputations of mean ICERs on the cost-effectiveness plane for the treatment groups by need level when using days of stable housing as the measure of effectiveness. Figures A3.a (HN) and A3.b (MN) (appendix) shows 1000 bootstrap replicates of mean ICERs on the cost-effectiveness plane for the treatment groups by need level when using days in apartment as the measure of effectiveness. When the measure of effectiveness was changed to days in apartment, half of the points for HN participants lay across the quadrant corresponding to higher costs and greater effectiveness while the other half lay in the quadrant corresponding to lower costs and greater effectiveness. For the MN participants, the points were more concentrated within the quadrant corresponding to lower costs and higher effectiveness. The mean ICER for the HN participants, HF with ACT was estimated as \$57.82 per additional day in an apartment (95% bias corrected and accelerated CI = undefined, 2,842.46) while the ICER for the MN participants, HF was again dominant (95% bias corrected and accelerated CI = undefined, 71.62). A negative correlation between incremental costs and incremental days was observed across both need levels and outcomes measures, suggesting that as the annual cost decreases days of stable housing/days in apartment increases. Upon further investigation, this negative correlation was observed at the individual level across both HF and TAU groups at both need levels and with both outcome

¹. Negative ICERs are difficult to interpret and are labeled as undefined in a confidence interval.

measures, though it was stronger for days of stable housing compared to days in apartment (see Figures A4.a, A4.b, A5.a, and A5.b appendix). The bootstrapping was repeated to include the ten TAU participants who were originally removed. Results were qualitatively similar with the only exception being the ICER for days of stable housing in the HN group which increased from \$872.58 to \$2,874 per additional day of stable housing.

Figures 1.a (HN) and 1.b (MN) show the CEACs generated by plotting the probability of HF being cost-effective against willingness-to-pay levels for both need levels when using days of stable housing as the outcome measure. When days of stable housing is used as the outcome, with a willingness to pay of \$0 per day, the probability of HF with ACT being cost-effective is 0.36. As the willingness to pay increases to \$250 per day, the probability of the intervention being cost-effective rises to 0.40. For the HF with ICM group, the corresponding figures are 0.69 and 0.96. Figures 2.a (HN) and 2.b (MN) show the cost-effectiveness acceptability curves generated at different willingness to pay levels for both need levels when using days in an apartment as the outcome measure. With a willingness to pay of \$0 per day, the probability of HF with ACT being cost-effective is 0.36. As the willingness to pay of \$0 per day, the probability of HF with ACT being cost-effective is 0.36. As the willingness to pay of \$0 per day, the probability of HF with ACT being cost-effective is 0.36. As the willingness to pay of \$0 per day, the probability of HF with ACT being cost-effective is 0.36. As the willingness to pay increases to \$250 per day, the probability rises to 0.78. For HF with ICM, the corresponding probabilities are 0.68 and 1.

5.4 Sensitivity Analysis

Table 4 shows the results of the one-way sensitivity analysis. Greater variations were found in the ICERs when the measure of effectiveness was days of stable housing for both need levels, though for MN participants, HF with ICM remained cost saving even when the cost of an HF apartment increased by up to 20%. The ICERs when days in an apartment were used were more robust to variation in the cost of an HF apartment for both need levels, though HF with ICM became less dominant for the MN group as the cost of the HF apartment increased up to 20%.

5.5 Net benefit Regression

Tables 5.a and 5.b show the results of the net monetary benefit regression at willingness to pay thresholds of \$0 to \$100 per day. For HN participants, a 10-point increase in the MCAS score, and a 1-month later recruitment date are associated with an increase in net monetary benefit per person per year; increments vary from \$29,132.79 (95% CI = 10,240.41, 48,025.16) at $\lambda = 0$ to \$28,255.67 (95% CI = 6,439.40, 50,071.94) at $\lambda = 100$ for MCAS score, and \$3,361.48 (95% CI = 614.55, 6,108.40) at $\lambda = 0$ to \$3,618.90 (95% CI = 377.17, 6,775.01) at $\lambda = 100$ for each additional month in date of recruitment. In addition, having one or more arrests or incarcerations in the past 6 months

at baseline is associated with a reduction net monetary benefit per person per year. This amount ranges from -\$38,248.77 (95% CI = -63,924.38, -12,573.15) at $\lambda = 0$ to -\$44,762.39 (95% CI = -74,411.26, -15,113.51) at $\lambda = 100$. For the MN group, none of the predictors, except for the interaction terms, were found to be significant at the 0.05 level.

5.6 Interaction terms for Regression

Interactions terms between being assigned to the HF group and two variables (age and having had two or more hospitalizations for mental illness during a 1-year period during the 5 years before baseline) were tested to determine if they affected the net monetary benefit of the regression. These interaction terms were considered in the previous AHCS analyses (20, 21), and were previously selected as they were found to be significant predictor in the cost-effectiveness of HF as certain characteristics were found to modify the effect of HF (20, 21). The only exception of the interaction term between recruitment and being assigned to the HF group is tested to examine if being part of the intervention longer affects the net monetary benefit as previously mentioned in the Methods section. However, this term was not significant for either need level, therefore, not included in the final model (results not shown). The Akaike information criterion was not impacted by the inclusion or removal of the interaction terms from the model for either need level. For the HN participants, none of the interaction terms are meaningful (results not shown), therefore, they are not included in the final model. For MN participants, the intervention was found to be more effective for older age groups, but it was statistically significant at all levels of λ for those in the older than 50 age group, and only significant for those between the ages of 30 and 49 at the highest willingness to pay threshold ($\lambda = 100$); amounts varied from \$70,105.85 (95% CI = 8,896.19, 131,315.51) at $\lambda = 0$ to \$89,626.09 (95% CI = 14,265.83, 164,986.35) at $\lambda = 100$ for ages older than 50 when receiving the intervention. The amount for 30-49 when receiving the intervention was 73,742.18 (95% CI = 50.96, 147,433.40). No other tested interaction terms appeared to meaningfully alter costs at any value of λ .

6. Discussion

The aim of this study was to evaluate the cost-effectiveness of what remained of HF services in Montreal 43-48 months post-baseline.

6.1 Cost-effectiveness of Housing First

For the MN group, the results suggest that HF with ICM was cost saving even after the intensity of support was reduced, while both outcome measures remained higher than for the TAU group. Similar to the modeling study that used the AHCS Montreal data, our findings suggest that HF with ICM could be cost-saving over time (139). The analysis for this study was done over a 4-year rather than a 10-year time horizon, and with reduced services. The results suggest that MN participants may in many cases be able to manage with less support and still maintain some degree of housing stability as seen in other studies (135-137). Additionally, in the MN group, HF with ICM participants had significantly lower costs in supportive housing and drop-in centers per person per year compared to TAU. The first is not surprising as 60% of the HF with ICM group had access to their original HF apartment: they would be less likely to use supportive housing. In addition, these participants had access to their own kitchen, and 30% of the HF with ICM group also had access to a case manager who may have connected them to employment or other activities. Their need for a drop-in center may thus have been reduced.

These results vary slightly from the original national AHCS study which found among MN participants, HF with ICM was associated with lower costs compared to TAU also for shelters, and ambulatory visits (21). These differences might be due to changes in services as HF participants with lower intensity of or without services altogether most likely had to increase their use of public services making them more similar to the TAU group. In addition, on average members of the TAU group spent more time on average in what were classified as stable housing situations, particularly other than living in an apartment. For HN participants, the ICER was estimated as \$872.59 per additional day of stable housing and \$53.58 per additional day in apartment. The first of these ICERs can hardly be interpreted as indicating cost-effectiveness. The importance of the measure of effectiveness is emphasized as HF is more cost-effective when using days in apartment rather than days of stable housing for HN participants. As for the MN group, TAU participants might have remained in hidden homelessness situations (e.g., living for 6 months or more with friends or family), or in social housing, when days of stable housing was used as the measure of effectiveness.

Additionally, the HF with ACT group also had significantly lower costs in a police cell per person per year compared to TAU. The significant differences in cost vary from the earlier studies conducted in France and Canada where HF services were implemented for 48 and up to 24 months, respectively. The French study found lower health and residential (defined as shelter and supportive housing services) costs for the HF with ACT group compared to TAU (122), while the Canadian study found lower costs associated with shelter, supportive housing, incarcerations, and ambulatory visits (20). Similarly, the results for HN participants may be explained by the loss of HF services which affected nearly half of the HF with ACT group, potentially leading them to return to their baseline use of certain public services. The ICERs from this study were different than the previous AHCS publication with the HN ICER being \$41.73 and MN ICER being \$56.03, with full services being offered to all participants during the follow-up period (20, 21). Additionally, when the measure of effectiveness was days of stable housing, the outcome was similar between the HF with ACT and TAU groups for HN participants, while the HF with ICM group had a higher average than TAU group for MN participants. Maintaining access to all HF services might be important for HN participants to remain stably housed as those with HN in the French study were able to maintain greater levels of housing stability compared to TAU at 48 months as they received all services during this period (123).

Nevertheless, days in an apartment were about twice as high for HF compared to TAU for both need levels. The measure of effectiveness is important to consider as using a stricter criterion for the measure of effectiveness increased the cost-effectiveness of HF with ACT among the HN participants. AHCS publications have used days of stable housing as a measure of effectiveness which includes any residence in which participants can stay for 6 months or longer generally including roommate situations or transitional housing (115). However, people experiencing homelessness tend to prefer living independently rather than in congregate or group homes that have preconditions (112, 113). Furthermore, the definition of days of stable housing for this study (and in AHCS) includes individuals who are considered to be homeless as per the Canadian homelessness classification (e.g., people in potentially unstable couch-surfing or transitional housing situations) and people in insecure housing situations as per the European ETHOS classification (24, 167). Thus, a stricter criterion would better reflect an exit from homelessness.

6.2 Bootstrapping

The analyses of uncertainty around the ICERs carried out using bootstrapping suggest that HF remains cost-effective for MN participants, regardless of measure of effectiveness. The probability of being cost-effective is contingent on the payor's willingness to pay for an additional day of stable housing, and the HF with ICM intervention had a probability of being cost-effective of at least 0.68 for all willingness-to-pay thresholds and when using both measures of effectiveness. The estimated probability of cost-effectiveness was somewhat lower than the one found at the 24month timepoint of the AHCS study (21). HF with ACT was less cost-effective when using days of stable housing rather than days in an apartment. As mentioned previously, this difference emphasizes the importance of the choice of measure of effectiveness as the HF with ACT group spent more days in an apartment compared to TAU among HN participants. Further, the difference in incremental effectiveness depending on the choice of measure might be due to the reduction of service, as mentioned previously: half of participants losing services likely led to fewer days of stable housing and lower cost offsets making the intervention appear less cost-effective compared to previously when the great majority of participants accessed services. Moreover, the estimated probability of being cost-effective for HF with ACT was much lower than the one reported at the 24-month timepoint of the AHCS study (21). This explanation is similar to the one for HF with ICM, however, the difference is greater due to the relatively greater loss in services experienced by those in the HF with ACT group. As noted above, the bootstrapping was redone using the ten TAU participants who were previously removed to avoid contamination bias. However, the inclusion of these participants did not change the conclusions except for the ICER using days of stable housing for the HN group. This change may be due to eight of the ten TAU participants being from the HN group who had access to ACT. This service possibly helped them stabilize their lives, thus potentially increasing their days in stable housing, but not increasing the days they spent in an apartment.

The plots on the cost-effectiveness plane show a negative correlation for both need levels between costs and measures of effectiveness. This pattern was also seen at the individual level for both need levels between costs and measures of effectiveness, in which this study was notably the first to find and report this pattern on an individual level. Overall, these patterns confirm what intuition would suggest, namely, that individuals with greater housing stability tend to have lower annualized costs.

6.3 Sensitivity analysis

The sensitivity analysis found that the ICER for the MN group was susceptible to fluctuations in the cost of HF apartments. HF was less dominant as the cost of HF apartment increased. However, the HN group was not as affected by this change. This is not surprising, considering more MN participants in the HF group were able to keep their HF apartments from the original study and had more days in an apartment compared to the HN HF participants. However, this also means that low-cost apartments are needed for those with MN for HF to remain cost saving compared to usual care.

6.4 Net Benefit regression

Unlike in At Home/Chez Soi reports at 21/24 months, HF was not significantly associated with increased net benefit for either need level. In the MN group, older age groups had higher net monetary benefit from HF with ICM compared to those below the age of 30. This is consistent with a previous study reporting that older individuals tended to keep supportive housing for a longer duration compared to younger participants (117). However, this interaction term was not significant in the previous AHCS paper using MN participants at 24-months (21). This finding may be due a greater portion of older adults continuing follow up in the MN group (over 40%) compared to the paper which only had 25% (21), though it is not known if age was associated with accessing HF apartments. The net benefit for HN participants found that community functioning and being recruited to the study later, was associated with higher net benefit while recent arrest history at baseline was associated with lower net benefit. The results with regards to community functioning are similar to those in the original study with HN participants for the first 2 years of follow-up (20). Being recruited into the study one month later was expected to be associated with decreased net benefit due to shorter exposure to the intervention. The opposite pattern, however, was observed.

6.5 Strengths and Limitations

Strengths of this study included the low loss to follow up with minimal differential attrition, high internal validity, a large sample size, and the use of inverse probability weighing. Most of the Montreal site sample was retained from the original study with almost 80% of participants followed up at the 48-month interview. Studies with homeless participants tend to have a follow-up at 18-36 months of between 60-80% (115). This study had a higher follow-up rate of 78%

which limited the chance of selection bias. Also, our sample had high internal validity as the baseline characteristics did not differ between the HF and TAU groups at 43-48 months, nor between baseline and 43-48-month samples, any differential attrition was minimal. Inverse probability weighting was also used to adjust for differences in the MCAS score between TAU participants who received treatment and the remaining sample. This method reduced the potential selection bias from the removal of the ten TAU participants.

Limitations of the study included the sampling, measures, analytical procedure, and lack of medication costs. It is unknown how many participants passed away prior to the 48-month interview. Those who were lost to follow-up could have impacted the costs and outcomes leading to potential selection bias. Regarding measures, data was collected from self-report questionnaires making them potentially susceptible to recall bias (19). An objective measure such as an administrative dataset for health and justice service use has been used in some HF studies (19, 53, 131, 132, 142-146, 149, 151-153), which could limit recall bias. Self-report questionnaires have, nonetheless, been shown to have some validity and/or been used in previous studies (9, 20-23, 158-160, 168). Further, in the original study, participants were found to have underreported the frequency of in-office and home visits. To adjust for this, intervention costs were multiplied by a factor to make those costs related to the intervention more accurate to the true cost as previously done (9). In addition, as mentioned in the Methods sections, missing data for residential stays was imputed using multiple imputation with chained equations. However, certain residential types were imputed with values of zero beforehand to reduce collinearity. This method could potentially impute zero values when the true values were non-zero, however, few participants (1.1%) had missing residential data, therefore it was not expected to impact the results materially. Additionally, cost of medication was not considered as it was not available for the AHCS study. Including these costs might influence the cost-effectiveness of the intervention.

6.6 Future directions

This study is the first to examine the cost-effectiveness of HF at the 43-48-month period following partial discontinuation of services at 24 months. Only one other Australian study examined an HF variant over the same timeframe following discontinuation of HF services at 36 months (129). The Australian study used an RCT design and randomized people experiencing homelessness to HF services (subsidized apartments with case management) with a skill (personal and vocational) development program or TAU. The findings were greater housing stability together with lower use

of the ED and of psychiatric services compared TAU at 48 months (129). A cost-benefit analysis was conducted; however, their findings were deemed inconclusive. This study and the Australian study provide future direction for examining costs or the cost-effectiveness of full HF services over the same period or greater. Thus, future studies examining HF over a greater period could determine if results of the previous modeling studies which used AHCS Montreal data and HF France could be replicated.

Variability in the findings regarding the cost-effectiveness of HF from this study and others like it brings to light the importance of participants' characteristics and context (122, 126, 130, 139, 143). The French HF study did not examine if HF costs were influenced by participants characteristics while this study and the previous AHCS publications found that characteristics such as age, community functioning, recent arrest history could influence the cost-effectiveness of HF (20, 21). Future studies could further examine which characteristics might impact the cost of HF. This study did not examine the impact of baseline characteristics on net costs due to potential bias of selfselection by HF participants. In particular, more compliant participants were suspected to have access to more services than less compliant participants. However, this could not be confirmed as this variable was not collected. Context is also an important consideration. In France, a monthly housing allowance is provided to most citizens under three different housing subsidy programs: family, social housing, and personal (for those who do not meet the criteria of family or social programs) (154). The housing allowance is considered as one of the costs in the social assistance benefits in the French study (122) and most likely covers the cost of the HF apartments leaving only the cost of the case management to be considered, thus, decreasing the overall cost of the intervention and net cost. Since Canada provides much less generous housing benefits (155), the cost of the intervention includes both the cost of the subsidized apartment and case-management making it more expensive for society to implement. These difference in social assistance structure suggests that the cost of HF intervention can be context dependent.

7. Conclusion

The systematic review found that HF was associated with a reduction in costs in services such as shelter, ED visits, and inpatient stays. However, these cost offsets, in the short term (< 2 years), tend to be less than the cost of the intervention. Modeling studies suggest that over a longer period (> 10 years), net costs can be reduced or even become negative. The findings were supported by those of the second part of the thesis which examined the cost-effectiveness of AHCS study at the 43-48 months time point, following a reduction in HF services in March 2013. At 43-48-months post-randomization at the Montreal AHCS site, following 24 months or less of reduced HF services, HF with ICM dominated TAU for MN participants as it was more effective (regardless of the measure of effectiveness) and less expensive. It may be that the intensity and therefore cost of HF support services decreased over time, as other studies have documented, while reductions in costs of services such as shelters, and ED visits continued at a reduced level. However, for HN participants, the HF with ACT group lost more services as 34% of participants had access to a rent subsidized apartment compared to 60% in the MN HF ICM group. The decrease in intensity and nature of services seems to have reduced the cost-effectiveness of HF for HN participants, as it was hardly more effective while still more expensive than the TAU group. However, this changed when the measure of effectiveness was modified to a stricter criterion with HF with ACT being more than twice as effective compared to TAU. These results suggest that HN participants may need intensive supports to be maintained longer for HF with ACT to remain cost-effective if the less restrictive AHCS definition of housing stability is maintained. Furthermore, net monetary benefit was higher for participants with higher community functioning and those recruited later, while recent arrest history at baseline was associated with lower net benefit; while for MN participants, the intervention appeared more cost-effective for older age groups. Future studies could consider examining the economic impact of HF over a greater duration than 48 months and further examine how contextual factors such as a country's housing benefits and characteristics of the participants may influence cost-effectiveness of HF.

 Table 1.a Baseline characteristics for HN group by group assignment and timepoint

	Baseline	48 months	Between HF	Baseline	48 months	Between	Between
	HN	HN	groups at	HN	HN	TAU groups	HF and
	HF&ACT	HF&ACT	baseline and	TAU	TAU	at baseline	TAU at 48
	(N=81)	(N=62)	48 months	(N=82)	(N=53)	and	months
						48 months	
			p-value				
						p-value	p-value
Age group			0.95			0.93	0.93
<30	14	12		12	9		
	(17.3%)	(19.4%)		(14.6%)	(17.0%)		
30-49	48	36		49	31		
	(59.3%)	(58.1%)		(59.8%)	(58.5%)		
50 ≥	19	14		21	13		
	(23.5%)	(22.6%)		(25.6%)	(24.5%)		
Gender			0.78			1.00	0.32
Female	22	19		17	11		
	(27.2%)	(30.6%)		(20.7%)	(20.8%)		
Male	59	43		65	42		
	(72.8%)	(69.4%)		(79.2%)	(79.2%)		
MCAS Score			0.94			0.43	0.52
Mean (SD)	52.0 (7.30)	52.1 (7.14)		52.1 (6.24)	52.9 (5.98)		
Aboriginal			1.00			1.00	1.00
Yes	1	1		2	1		
	(1.2%)	(1.6%)		(2.4%)	(1.9%)		
No	80	61		80	52		
	(98.8%)	(98.4%)		(97.6%)	(98.1%)		
Ethnoracial			0.74			0.89	1.00
Yes	25	10		22	9		
	(30.8%)	(16.1%)		(26.8%)	(17.0%)		
No	56	52		60	44		
	(69.2%)	(83.9%)		(73.2%)	(83.0%)		

Education ^b			0.81			0.73	0.93
Less than High	46	39		44	32		
School	(56.8%)	(62.9%)		(53.6%)	(60.4%)		
Completed High	15	10		17	10		
School	(18.6%)	(16.1%)		(20.8%)	(18.9%)		
Any post-	19	13		21	11		
secondary school	(23.4%)	(21.0%)		(25.6%)	(20.8%)		
Alcohol and/or subs	stance abuse an	d/or	0.45			0.83	1.00
dependence at basel	line						
Yes	60	50		64	43		
	(74.0%)	(80.6%)		(78.0%)	(81.1%)		
No	21	12		18	10		
	(26.0%)	(19.4%)		(22.0%)	(18.9%)		
Longest period hom	eless (months)		0.84			0.82	0.13
Mean (SD)	40.4 (57.1)	42.5 (60.9)		33.4 (45.6)	31.5 (45.7)		
Diagnosis ^a			0.86			0.71	0.35
Major depressive	0 (0%)	0 (0%)		0 (0%)	0 (0%)		
disorder							
Mania –	6 (7.4%)	4 (6.5%)		9 (11.0%)	7 (13.2%)		
Hypomania							
PTSD	0 (0%)	0 (0%)		0 (0%)	0 (0%)		
Mood disorder	0 (0%)	0 (0%)		0 (0%)	0 (0%)		
with psychotic							
features							
Panic Disorder	7	7		9	8		
	(4.3%)	(11.3%)		(11.0%)	(15.1%)		
Psychotic Disorder	68	51		64	38		
	(84.0%)	(82.3%)		(76.8%)	(71.7%)		
Marital Status			0.95			1.00	0.45
Married/partnered	1	1		0	0		
	(0.6%)	(1.6%)		(0%)	(0%)		
Single, never	67	52		74	48		
married	(92.8%)	(83.9%)		(90.2%)	(90.6%)		

D 1/ 1	10	0		-	_		1
Divorced/separated	13	9		8	5		
/widowed	(16.0%)	(14.5%)		(9.8%)	(9.4%)		
Recent arrest histor	·y ^c		0.95			1.00	1.00
Yes	29	21		28	18		
	(35.8%)	(33.9%)		(34.2%)	(34.0%)		
No	52	41		53	35		
	(64.2%)	(66.1%)		(64.6%)	(66.0%)		
Hospitalization hist	ory ^{d, e}		1.00			0.98	0.26
Yes	41	31		49	33		
	(50.6%)	(50.0%)		(59.8%)	(62.3%)		
No	38	31		31	20		
	(42.4%)	(50.0%)		(35.4%)	(37.7%)		
Services received in	the past 6 mor	nths					
ACT	NA	11 (17.7%)		NA	0 (0%)		
No Service	NA	29 (46.8%)		NA	53 (100%)		
Subsidy + ACT	NA	11 (17.7%)		NA	0 (0%)		
Subsidy Without	NA	11 (17.7%)		NA	0 (0%)		
ACT							

a - For high-need participants, a diagnosis of psychotic disorder or mania/hypomania was required. However, the principal diagnosis was determined by matching the diagnosis from the MINI conducted at baseline with the participant's medical records. Participants in the HN group all had the psychosis or mania diagnosis present at baseline, but for some it was considered a comorbidity rather than their principal diagnosis

b - 1 missing in the HF group at baseline

c - Defined as having one or more arrests or incarcerations in the past 6 months at the time of recruitment

d - Defined as having two or more hospitalizations for mental illness within a 1-year period at some point during the previous 5 year.

e - 2 missing in the HF group at baseline and 2 missing in the TAU group at baseline

 Table 1.b Baseline characteristics for MN group by group assignment and timepoint

	Baseline	4 year	Between	Baseline	4 year	Between	Between
	IVIN HE ICM		HF groups of			IAU groups at	HF and TAU at 48
	(N-204)	(N-156)	groups at baseline	(N-102)	(N-78)	baseline	TAU at 40 months
	(11-204)	(11-150)	and	(11-102)	(11-70)	and	monuis
			48			48 months	
			months			10 1101101	
						p-value	p-value
			p-value				•
Age groups		·	0.92			0.88	0.46
<30	11 (5.4%)	10 (6.4%)		4 (3.9%)	2 (2.6%)		
30 - 49	109 (53.4%)	82 (52.6%)		55 (53.9%)	42 (53.8%)		
50 ≥	84 (41.2%)	64 (41.0%)		43 (42.2%)	34 (43.6%)		
Gender			0.98			1.00	0.21
Male	123 (60.2%)	93 (59.6%)		71 (69.6%)	54 (69.2%)		
Female	81 (39.2%)	63 (40.4%)		31 (30.4%)	24 (30.8%)		
MCAS Score			0.68			0.54	0.49
Mean (SD)	65.5 (6.46)	65.9 (6.46)		65.3 (7.02)	65.9 (6.46)		
Aboriginal			0.92			1.00	1.00
Yes	5 (1.4%)	5 (3.2%)		2 (1.0%)	2 (2.6%)		
No	199 (97.5%)	151 (96.8%)		100 (99.0%)	76 (97.4%)		
Ethnoracial		1	1.00		1	0.94	0.95
Yes	24 (11.8%)	18 (11.5%)		12 (11.8%)	8 (10.3%)		
No	180 (88.2%)	138 (88.5%)		90 (88.2%)	70 (89.7%)		
Education ^a			0.85			1.00	0.97
Less than High	91 (44.6%)	74 (47.4%)		47 (46.0%)	36 (46.2%)		
School							
Completed High	46 (22.6%)	32 (20.5%)		22 (21.6%)	17 (21.8%)		
School							

Any post- secondary school	67 (32.8%)	50 (32.1%)		32 (30.4%)	25 (32.1%)		
Alcohol or substa	ance abuse or de	pendence at	0.90			0.82	0.71
baseline	-						
Yes	108 (53.0%)	85 (54.5%)		56 (55.0%)	45 (57.7%)		
No	96 (47%)	71 (45.5%)		46 (45.0%)	33 (42.3%)		
Longest period h	omeless (months)b	0.50			0.93	0.83
Mean (SD)	24.8 (45.4)	28.4 (49.9)		26.1 (29.2)	26.4 (29.3)		
Diagnosis ^c			0.99			0.97	0.98
Major	106 (52.0%)	80 (51.3%)		49 (48.0%)	39 (50.0%)		
depressive							
disorder							
Mania –	22 (10.8%)	21 (13.5%)		15 (14.7%)	9 (11.5%)		
Hypomania							
PTSD	4 (2.0%)	3 (1.9%)		1 (1.0%)	1 (1.3%)		
Mood disorder	6 (2.9%)	3 (1.9%)		2 (2.0%)	1 (1.3%)		
with psychotic							
features							
Panic Disorder	9 (4.4%)	6 (3.8%)		10 (9.8%)	10 (12.8%)		
Psychotic	52 (26.0%)	43 (27.6%)		25 (24.5%)	18 (23.1%)		
Disorder							
Marital Status			0.59			0.94	0.28
Single, never	141 (69.2%	105 (67.3%)		72 (70.6%)	55 (70.5%)		
married							
Married/	1 (0.4%)	0 (0%)		2 (2.0%)	1 (1.3%)		
partnered							
Divorced/	62 (30.4%)	51 (32.7%)		28 (27.4%)	22 (28.2%)		
separated/							
widowed							
Recent arrest his	tory ^d		0.86			0.96	0.09
Yes	43 (21.0%)	31 (19.9%)		69 (66.6%)	54 (67.9%)		
No	160 (78.4%)	125 (80.1%)		33 (32.4%)	24 (30.8%)		

Hospitalization h	nistory		0.87			0.89	1.00
Yes	59 (29.0%)	43 (27.64%)		31 (30.4%)	22 (28.2%)		
No	145 (68.6%)	113 (72.46%)		71 (68.6%)	56 (71.8%)		
Services received	l in the past 6 mo	onths					
ICM		11 (7.1%)			0 (0%)		
No Service		51 (32.7%)			78 (100%)		
Subsidy + ICM		40 (25.6%)			0 (0%)		
Subsidy		54 (34.6%)			0 (0%)		
Without ICM							

a - 1 missing TAU group at baseline

b - 1 missing in the HF group at baseline and 4 year

c - 5 missing HF group at baseline

d - 1 missing HF group at baseline

Table 2.a Annualized costs (CAD) for HN participants by group assignment at 43-48months

	HN	HN	Difference
	HF&ACT	TAU	(HF – TAU)
	(N=62)	(N=53)	
	M (SD)	M (SD)	D (95% CI)
Health Service Provider and	4,325 (9,795)	5,164 (11,013)	-839
outpatient ^a			(-4722, 3045)
ED visits	1,146 (4,354)	1,216 (3,078)	-70
			(-1,449, 1,310)
Ambulance	512 (1,642)	581 (1,478)	-69
			(-645, 508)
911	23 (71)	31 (102)	-8
			(-41, 25)
811	41 (218)	39 (149)	3
			(-65, 71)
Stay in detox center	2,106 (7,393)	2,825 (10,729)	719
			(-4190, 2753)
Shelter	1,478 (3,962)	4,044 (12,223)	-2,566
			(-6070, 939)
Hospital stay for physical	0 (0)	10,035 (56,583)	-10,035
causes			(-25,631, 5,561)
Hospital stay for psychiatric	22,457 (63,868)	16,552 (59,364)	5,906
causes			(-16,883, 28,694)
Incarceration	5,904 (17,417)	2,726 (9,492)	4,178
			(-1918, 8274)
Police cell	10 (81)	97 (292)	-87*
			(-169, -4)
Police contact	3,872 (12,537)	963 (2,605)	2,910
			(-348, 6167)
Court appearance	6,351 (12,150)	4,079 (12,358)	2,272
			(-2,274, 6,819)
Arrests	496 (1648)	470 (1869)	26
			(-634, 686)
Other justice services ^b	96 (760)	122 (640)	26
			(-284, 233)
Social Services ^c	1,928 (8,223)	1,520 (3,873)	407
			(-1922, 2736)
Supportive Housing ^d	1,737 (11,363)	5,509 (13,826)	-3,772
			(-8,504,960)
Drop-in center	2,225 (4,186)	2,183 (4,311)	42
			(-1,535, 1,619)
Foodbank	45 (89)	56 (119)	-11
			(-50, 29)

Community meal program	160 (461)	173 (490)	-12
			(-189, 165)
Crisis line	97 (494)	5 (28)	92
			(-34, 217)
Crisis team	0 (0)	18.34 (94)	-18
			(-44, 7)
Intervention Cost	8,859 (12,464)	0 (0)	8,859
			(5,694, 12,024)
Social Assistance/Disability	8,447 (4,069)	8,882 (3,980)	-435
			(-2,077, 905)
Employment Income	608 (3,570)	0 (0)	607
			(-299, 1,514)
Total cost (without cost of	62,953	67,448 (77,755)	-4,495
intervention) ^e	(65,718)		(-31,549, 22,351)
Total cost (with intervention)	71,859	67,448 (77,755)	4,260
	(63,012)		(-22,274, 30,794)

a - Health service use was defined as the sum of all appointments/visits (at home or at the office) with a health care provider (e.g. doctor, nurse, dentist, etc.) and outpatient visits.

b - Social service use was defined as the sum of all appointments/visits (at home or at the office) with a social service provider (e.g. social worker).

c - Justice service use was defined as the sum of all appointments/visits (at home or at the office) with a justice service provider (e.g. probation officer).

d - Includes both rooms in buildings with on-site support staff.

e - Total was calculated by summing all costs categories and subtracting the total from earned income.

* p < .05

	MN	MN	Difference
	HF + ICM	TAU	(HF – TAU)
	(N=156)	(N=78)	
	M (SD)	M (SD)	D (95% CI)
Health Service Provider and	1,943	2,458 (4,486)	-515
outpatient ^a	(4,732)		(-1,766,737)
ED visits	1,293	1,144 (4,043)	148
	(5,507)		(-1,105, 1,402)
Ambulance	296 (730)	481 (1,557)	-185
			(-554, 184)
911	36	62	-26
	(173)	(278)	(-94, 42)
811	21	31	-9
	(55)	(105)	(-34, 16)
Stay in detox center	783 (4,966)	1,382 (6,809)	-599
			(-2,317,
			1,119)
Shelter	2,689 (8,500)	3,607 (8,562)	-918
			(-3,258, 1,422)
Hospital stay for physical causes	817 (5,315)	5,269 (20,407)	-4,452
			(-9,126,
			4,222)
Hospital stay for psychiatric causes	4,566 (22,362)	2,706 (18,608)	1,860
			(-3,595, 7,316)
Incarceration	3,763 (20,593)	4,054 (18,730)	-291
			(-5,013, 5,594)
Police cell	49	16	33
	(225)	(102)	(-9, 75)
Police contact	997 (5,614)	755 (2,015)	242
			(-752, 1,225)
Court appearance	3,267 (8,183)	2,574 (6,778)	693
			(-1 298,
			2,684)
Arrests	141 (519)	113 (457)	27
			(-103, 159)
Other justice services ^b	143 (1,108)	138 (792)	5
			(-244, 254)
Social Services ^c	1,937 (5,548)	1,431 (4,525)	506
			(-832, 1,843)
Supportive Housing ^d	2,357 (10,766)	6,462 (12,628)	-4,105*
_			(-7,407,
			-803)

Table 2.b Annualized costs (CAD) for MN participants by group assignment at 43-48months

Drop-in center	1,182 (3,227)	2,767 (4,594)	-1,585*
-			(-2,735,
			-435)
Foodbank	37	48	-11
	(78)	(93)	(-35, 13)
Community meal program	180	195	-15
	(632)	(643)	(-190, 160)
Crisis line	24	14	9
	(139)	(56)	(-16, 35)
Crisis team	19	31	-12
	(94)	(181)	(-56, 31)
Intervention Cost	8,226 (8,861)	0	8,190
		(0)	(6,786, 9,594)
Social Assistance/Disability	8,132 (4,270)	8,063 (4,057)	177
			(-914, 1,349)
Employment Income	1,101 (5,007)	823 (3,754)	278
			(-872 1429)
Total cost (without cost of	34,563	44,301	-9,738.37
intervention) ^e	(43,929)	(37,501)	(-19,395.21,
			813.53)
Total cost (with intervention)	\$42,894	44,301	-1,408
	(\$40,066)	(37,501)	(-11,199,
			9,070)

a - Health service use was defined as the sum of all appointments/visits (at home or at the office) with a health care provider (e.g. doctor, nurse, dentist, etc.) and outpatient visits.

b - Social service use was defined as the sum of all appointments/visits (at home or at the office) with a social service provider (e.g. social worker).

c - Justice service use was defined as the sum of all appointments/visits (at home or at the office) with a justice service provider (e.g. probation officer).

d - Includes both rooms in buildings with on-site support staff.

e - Total was calculated by summing all costs categories and subtracting the total from earned income.

*p < .05

Group	Average cost per person per year M (SD)	Average days of stable housing per year M (SD)	Average days in an apartment per year M (SD)	ICER (using days of stable housing, 95% bias corrected and accelerated CI)	ICER (using days in an apartment, 95% bias corrected and accelerated CI)
HN HF&ACT (N=62)	71,859 (63,012)	200.45 (168.83)	166.32 (170.19)	\$873 (undefined, \$3,150)	\$54 (undefined, \$2,842)
HN TAU (N=53)	67,448 (77,755)	195.40 (171.68)	84.00 (146.77)		
MN HF + ICM (N=156)	42,894 (40,066)	273.60 (137.30)	237.47 (158.18)	Dominant (undefined, \$3,56)	Dominant (undefined, \$71)
MN TAU (N=78)	44,301 (37,501)	225.33 (165.41)	107.49 (158.05)		

 Table 3. Incremental cost-effectiveness ratios by group at 43-48 months

Figure 1.a Cost-effectiveness acceptability curve for the HN group, using days of stable housing as the measure of effectiveness



Cost-effectiveness acceptability curve HN (HF + ACT)

Figure 1.b Cost-effectiveness acceptability curve for the MN group, using days of stable housing as the measure of effectiveness



Cost-effectiveness acceptability curve MN (HF + ICM)

Figure 2.a Cost-effectiveness acceptability curve for the HN group, using days in an apartment as the measure of effectiveness



Cost-effectiveness acceptability curve HN (HF + ACT) using

Figure 2.b Cost-effectiveness acceptability curve for the MN group, using days in an apartment as the measure of effectiveness



Group	Case type	Annual cost	ICER (Using days of stable housing)	ICER (Using days in apartment)
HN HF&ACT (N=62)	Base Case	71,859	\$873	\$54
	Lower	72,086	\$918	\$56
	Upper	72,540	\$1,008	\$62
MN HF + ICM (156)	Base Case	42,894	Dominant	Dominant
	Lower	43,387	Dominant	Dominant
	Upper	43,880	Dominant	Dominant

Table 4. Sensitivity Analysis using variation in cost of HF apartment

Estimated β Coefficient (95% CI), 2022 CAD^a $\lambda = \$0$ $\lambda =$ \$40 $\lambda =$ \$20 95% CI 95% CI M(SE) 95% CI Term M(SE) M(SE) HF + ACT-1,918 -25,705,-1,907 -26,346, -1,895 -27,032, (12, 136)21,868 (12, 469)22,533 (12, 825)23,243 Gender 12,880 -15,475, 12,323 -16,810, 11,766 -18,199, Male (14, 467)41,235 (16, 890)41,456 (15,288)41,731 Age^b 30-49 27,715 -4,506, 28,637 -4,468, 29,559 -4,492, (16, 439)59,936 (16, 890)61,742 (17, 373)63,610 \geq 50 -18,854, 20,226 -19,654, 19,611 -18,126, 19,918 (19,253)57,347 (19782)58.691 (20, 347)60,106 MCAS Score^c 29,133* 10,240, 28,957* 9,547, 48,368 28,782* 8,817, 48,025 48,747 (9.639)(9,903)(10, 186)Alcohol or 31.783* 1,691.07, 32,177 -275, 65, 679 32,570 -375, substance abuse 66,907 (16, 102.05)64,012 (16,557)(16, 426)or dependence at Baseline^d Hospitalization -23,801, 2,725 -24,405, -25,060, 2,605 2,8461 history^e (13, 472)29,011 (13,842)29,856 (14, 238)30,752 Arrest history^f -38.249* -63.924. -39.551* -65.931. -40.854* -67.987. -12,573 -13,172 -13,721 (13.100)(13, 459)(13, 843)Longest months -60 -222, 233 -1 -235, 232 -8 -249, 232 homeless^g (116)(119)(123)3,361* 3,413* 591, 6,235 3,464* Month 615.6.108 562, 6, 367 Recruited^h (1401)(1440)(1, 481) $\lambda = \$80$ $\lambda =$ \$60 $\lambda =$ \$100 M(SE) 95% CI M(SE) 95% CI M (SE) 95% CI HF + ACT-1,883 -27,760, -1,871 -28,527, -1,860 -29,329, (13,600) 23,994 24,784 25.609 (13,203)(14,015)Gender 11,209 -19,638, 10,652 -21,123,10,095 -22,650 42,056 (16, 212)42,427 (16,706)42,839 Male (15,738)Age -4,884, 30-49 30,481 -4,572, 31,403 -4,704, 32,325 (18,422) 65,534 67,510 69,534 (17,884)(18,984) ≥ 50 20.534 -20,520, 20.842 -21.447. 21.149 -22,429,(20,946)61,587 (21, 576)63,130 (22, 234)64,728 MCAS Score 28,607* 28,431* 7,261, 28,256* 6,439, 8,054, 49,159 (10, 486)(10801)49,602 (11, 131)50,072 Alcohol or -1,082, -1,841, -2,646, 34,125 34,414 34,702 substance abuse (17, 466)68,191 (18,055)69,526 (18,606)70,909

Table 5.a Net benefit regression results of the HN group for various values assigned to anadditional day of stable housing

or dependence						
at baseline						
Hospitalization	2,967	-25,760,	3,088	-26,503,	3,208	-27,286,
history	(14,657)	31,694	(15,097)	32,679	(15,558)	33,702
Arrest history	-42,157*	-70,089,	-43,460*	-72,231, -	-44,762*	-74,411,
	(14,251)	-14,225	(14,679)	14,688	(15,127)	-15,114
Longest months	-16	-264, 231	-24	-279, 231	-31	-297, 234
homeless	(126)		(130)		(134)	
Month	3,516*	528, 6,504	3,567*	489, 6,645	3,619*	377, 6775
Recruited	(1,525)		(1,570)		(1,618)	

a - Decision maker's willingness to pay for an additional day of stable housing.

b - Reference, age 30 or younger.

c - Multnomah Community Ability Scale. Coefficients indicate partial association with a 10-point increase in MCAS score

d - Reference, no alcohol or substance abuse or dependence.

e - Two or more hospitalizations for mental illness during a 1-year period during the 5 years before baseline.

f - One or more arrests or incarcerations in the 6 months before baseline.

g - During lifetime, in months.

h - Reference month was when recruitment began in October 2009. Coefficients indicate partial association with a month later recruitment until May 2011.

*p < .05

	Estimated β Coefficient (95% CI), 2022 CAD ^a							
	$\lambda = $		$\lambda = \$20$		$\lambda = $ \$40			
Term	M (SE)	95% CI	M (SE)	95% CI	M (SE)	95% CI		
HF + ICM	-58,118	-118,100,	-61,177	-123,499	-64,236	-129,141,		
	(30,603)	1,864	(31,797)	1,145	(33,115)	670		
Gender	10,202	-384,	9,903	-693,	9,604	-1,431,		
Male	(5,203)	20,400	(5,406)	20,499	(5,630)	20,639		
Age ^b								
30-49	-4,260	-59,035,	-6,180	-63,092,	-8,100	-67,371,		
	(27,947)	50,516	(29,037)	50,733	(30,241)	51,172		
\geq 50	-6,909	-62,824,	-8,075	-66,172,	-9,241	-69,746,		
	(28,528)	49,007	(29,641)	50,022	(30,870)	51,263		
MCAS Score ^c	3,619	-4,076,	4,313	-3,681,	5008	-3,318,		
	(3,926)	11,314	(4,079)	12,308	(4,248)	13,333		
Alcohol or	-694	-11,810,	-577	-11,050,	-460	- 11,368,		
substance abuse	(5,143)	1,864	(5,344)	9,896	(5,565)	10,447		
or dependence								
at Baseline ^d								
Hospitalization	-6,734	-26,448,	-6,973	-27,456,	-7,212	-28,544,		
history ^e	(10,058)	12,981	(10,451)	13,510	(10,884)	14,120		
Arrest history ^t	-5,788	-17,777,	-6,326	-18,782,	-6,863	-19,836,		
	(6,117)	6,201	(6,356)	6,131	(6,619)	6,110		
Longest months	-17	-130, 95	-21	-138, 97	-24	-146,		
homeless ^g	(58)		(60)		(62)	98		
Month	140	-931, 1,210	190 (568)	-923, 1,303	240 (591)	-918, 1,399		
Recruited ⁿ	(546)							
$HF \times 30-49$	52,409	-7,445,	56,676	-5,513	60,942	-3,824,		
	(30,538)	112,263	(31,729)	118,865	(33,044)	125,709		
$\text{HF} \times \geq 50$	70,106*	8,896	74,010*	10,412,	77,914*	11,680,		
	(31,229)	131,316	(32,448)	137,607	(33,793)	144,148		
HF×	10,075	-13,419,	10,204	-14,206,	10,333	-15,088,		
Hospitalization	(11,986)	33,568	(12,454)	34,613	(12,970)	35,754		
	$\lambda = \$60$		$\lambda = \$80$		$\lambda = \$100$			
	M (SE)	95% CI	M	95% CI	M (SE)	95% CI		
HF + ICM	-67,295	-134,999,	-70,354	-141,047,	-73,413	-147,262,		
	(34,543)	409	(36,068)	339	(37,678)	436		
Gender	9,305	-2,206,	9,006	-3,013,	8,707	-3,848,		
Male	(5,873)	20,816	(6,132)	21,025	(6,406)	21,263		
Age								
30-49	-10,020	-71,847,	-11,940	-76,497,	-13,860	-81,298,		
	(31,545)	51,808	(32,937)	52,617	(34,407)	53,579		

Table 5.b Net benefit regression results of the MN group for various values assigned to an additional day of stable housing, with interaction terms
\geq 50	-10,408	-73,522,	-11,574	-77,475,	-12,741	-81,583,
	(32,201)	52,706	(33,623)	54,326	(35,123)	56,101
MCAS Score	5,702	-2,982,	6,396	-2,671,	7,090	-2,380,
	(4,431)	14,386	(4,626)	15,462	(4,832)	16,561
Alcohol or	-343	-11,721,	-226	-12,106,	-110	-12,520,
substance abuse	(5,805)	11,034	(6,061)	11,654	(6,332)	12,301
or dependence						
at Baseline						
Hospitalization	-7,451	-29,703,	-7,690	-30,924,	-7,929	-32,200,
history	(11,353)	14,801	(11,854)	15,544	(12,383)	16,342
Arrest history	-7,401	-20,933,	-7,939	-22,068,	-8,476	-23,237,
	(6,904)	6,132	(7,209)	6,191	(7,531)	6,285
Longest months	-27	-155, 100	-31	-164, 102	-34	-173, 105
homeless	(65)		(68)		(71)	
Month	291	-918, 1,500	341	-921, 1,603	392	-927, 1710
Recruited	(617)		(644)		(673)	
HF × 30-49	65,209	-2,351,	69,476	-1,067,	73,742*	51, 147,433
	(34,469)	132,769	(35,991)	140,018	(37,598)	
$\text{HF} \times \geq 50$	81,818*	12,728,	85,722*	13,582,	89,626*	14,266,
	(35,250)	150,908	(36,806)	157,862	(38,449)	164,986
$HF \times$	10,462	-16,055,	10,591	-17,096,	10,720	-18,203,
Hospitalization	(13,529)	36,979	(14,126)	38,279	(14,757)	39,643

a – Decision maker's willingness to pay for an additional day of stable housing.

b – Reference, age 30 or younger.

c – Multnomah Community Ability Scale. Coefficients indicate partial association with a 10-point increase in MCAS score

d – Reference, no alcohol or substance abuse or dependence.

e – Two or more hospitalizations for mental illness during a 1-year period during the 5 years before baseline.

f – One or more arrests or incarcerations in the 6 months before baseline.

g – During lifetime, in months.

h - Reference month was when recruitment began in October 2009. Coefficients indicate partial association with a month later recruitment until May 2011.

*p < .05

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Figure A1. Boxplots for total annual cost by group at 43-48 months from one imputed dataset



Annual cost by group assignment

Figure A2.a Bootstrap replicates on the cost-effectiveness plane for the HN group (n = 1000) when effectiveness is measured as days of stable housing



Figure A2.b Bootstrap replicates on the cost-effectiveness plane for the MN group (n = 1000) when effectiveness is measured as days of stable housing



Figure A3.a Bootstrap replicates on the cost-effectiveness plan for the HN group, using days in apartment as the measure of effectiveness



Cost-effectiveness acceptability curve HN (HF + ACT) using days in apartment

Figure A3.b Bootstrap replicates on the cost-effectiveness plan for the MN group, using days in an apartment as the measure of effectiveness



Cost-effectiveness acceptability curve HN (HF + ICM) using days in apartment

Figure A4.a Annualized cost by days of stable housing - HN group, for one imputed dataset



HN sample - Scatter plot - Correlation between annual cost and days of stable housing

Figure A4.b Annualized cost by days of stable housing - MN group, for one imputed dataset





Figure A5.a Annualized cost by days in apartment - HN group, for one imputed dataset

Figure A5.b Annualized cost by days in apartment - MN group, for one imputed dataset

