




# One year follow-up and exploratory analysis of a patient-centered interdisciplinary care intervention for multimorbidity

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Martin Fortin, MD, MSc<sup>1</sup> , Moira Stewart, PhD<sup>2</sup>, José Almirall, MD, PhD<sup>1</sup>, Djamal Berbiche<sup>1</sup>, Mathieu Bélanger, PhD<sup>1</sup>, Alan Katz, MB, ChB, MSc<sup>3</sup>, Bridget L Ryan, PhD<sup>2</sup> , Sabrina T Wong, RN, PhD<sup>4</sup> and Merrick Zwarenstein, MB, BCh, PhD<sup>2</sup>

## Abstract

**Context:** Interventions for people with multimorbidity have obtained mixed results. We aimed to document the long-term effect of an intervention for people with multimorbidity.

**Methods:** 284 patients (18–80 years) presenting three or more chronic conditions were recruited from seven family medicine groups in the Saguenay-Lac St-Jean region, Quebec, Canada. The patient-centered intervention was based on motivational approach and self-management support. Outcomes were evaluated in a one-year pre-post study design with questionnaires that included the Health Education Questionnaire (heiQ), the Self-Efficacy for Managing Chronic Diseases, the Veteran RAND-12 Health Survey (VR-12), the EuroQoL 5-Domains questionnaire, the Kessler six item Psychological Stress Scale, and measures of smoking habit, physical activity, healthy eating and alcohol consumption. Subgroup analyses by age, number of conditions, sex, and income were also conducted.

**Results:** The heiQ domain of emotional wellbeing improved significantly. Improvement was also observed for the VR-12 and the K6. Among the health behaviours, only healthy eating was improved. Subgroup analyses in this exploratory study suggest that younger patients, those with lower number of chronic conditions or higher incomes may respond better in relation to self-management, health status and health behaviours.

**Conclusion:** One year after the intervention, participants significantly improved a variety of outcomes. Subgroup analyses suggest that younger patients, those with lower number of chronic conditions or higher incomes may respond better in relation to self-management, health status and health behaviours. This suggests that future interventions should be tailored to patients' characteristics including age, sex, income and number of conditions.

## Keywords

Multimorbidity, patient outcome assessment, patient care team

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<sup>1</sup>Université de Sherbrooke, Chicoutimi, QC, Canada

<sup>2</sup>Western University, London, ON, Canada

<sup>3</sup>University of Manitoba, Winnipeg, MB, Canada

<sup>4</sup>University of British Columbia, Vancouver, BC, Canada

## Introduction

Multimorbidity, the presence of more than one chronic medical condition in the same individual, is the number one

### Corresponding author:

Martin Fortin, Department of Family Medicine and Emergency Medicine, Université de Sherbrooke, Hôpital de Chicoutimi, 305 St-Vallier, Chicoutimi, QC G7H5H6, Canada.

Email: [Martin.Fortin@usherbrooke.ca](mailto:Martin.Fortin@usherbrooke.ca)



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challenge in primary health care.<sup>1,2</sup> It is associated with poorer quality of life,<sup>3,4</sup> functional decline,<sup>5,6</sup> increased health care utilisation<sup>7,8</sup> and complex management with drugs which often leads to polypharmacy.<sup>9,10</sup> Fragmentation of care due to the involvement of both primary care and multiple specialists, who may not be effectively communicating with each other, is a problem frequently faced by these patients.<sup>11</sup>

Different attempts have been made to create effective interventions in primary care for people with multimorbidity, being the predominant intervention element a change to the organisation of care delivery.<sup>12</sup> However, these interventions have obtained mixed results.<sup>12</sup>

We recently reported the results of a trial assessing the effectiveness of a multifaceted intervention based on a change in care delivery for patients with three or more chronic conditions. After 4 months, the intervention showed a neutral effect on the primary outcomes and substantial improvement in 2 health behaviours as secondary outcomes. However, the effect of the intervention after a longer period of time was not known. In the present study, we aim to analyse the 1-year outcomes after exposure to the intervention.

## Methods

The Patient-Centred Innovations for Persons with Multimorbidity (PACE in MM) research programme, funded by the Canadian Institutes of Health Research, had a goal of evaluating the effectiveness of a complex, interdisciplinary and multipronged patient-centred intervention in primary health care.<sup>13</sup> In particular, a pragmatic randomised controlled trial was used to evaluate the effectiveness of this intervention, which involved change in care delivery model for people with three or more chronic conditions in the province of Quebec, Canada. The 4-months intervention took place in Family Medicine Groups (FMGs), the most prevalent type of primary care practices in Quebec.<sup>14</sup> This type of practices are characterised by group and interprofessional work, registration and follow-up of patients with a particular doctor, and a service allowing registered patients to benefit from integrated services offered in extended hours.

In comparison to patients receiving usual care, exposure to the patient-specific interdisciplinary care model was associated with improvements in self-monitoring and insight, physical activity level and healthy eating. At the end of the trial, the control group also received the intervention. This article reports results, combining all participants in one single group that received the intervention, on the one-year outcomes after exposure to the intervention, to document its long-term association with measures of self-care, quality of life and health-related behaviours. A follow-up of 1 year is a period of time frequently used in the evaluation of interventions for improving outcomes in patients with multimorbidity in primary care.<sup>12</sup> Changes in these measures are

**Table 1.** Description of the population.

	<i>n</i> = 284
	Mean (SD.)
<b>Age (yr.)</b>	60.9 (10.4)
<b>Number of chronic diseases</b>	5.0 (1.8)
<b><i>n</i> (%)</b>	
<b>Males</b>	132 (46.5)
<b>Education level</b>	
Incomplete secondary school	66 (23.2)
Completed secondary school	68 (23.9)
College	120 (42.3)
University	30 (10.6)
<b>Household income in CAD\$</b>	
< US\$20,000	52 (18.3)
US\$20,000-US\$49,999	106 (37.3)
US\$50,000 or more	114 (40.1)
Missing data	12 (4.2)
<b>Marital status</b>	
Married	184 (64.8)
Single or divorced	86 (30.3)
Widowed	14 (4.9)
<b>Employment</b>	
Employed	96 (33.8)
Unemployed	52 (18.3)
Retired	136 (47.9)

analysed across age-, number of chronic conditions-, income-, and gender-based subgroups to explore factors potentially associated with variation in response to the intervention and help guide the development of more targeted interventions in the future. For the age-based subgroup, we divided the subjects according to the median of the group.

## Setting and intervention

This study recruited seven FMGs in the Saguenay-Lac St-Jean region and recruited patients from these practices. The multipronged intervention encompassed three components: 1) training of the professionals of the participating practices (nurses, nutritionists and kinesiologists or other professionals if present) on four themes: patient-centred care for persons with multimorbidity; self-management support; interprofessional collaboration; and motivational interviewing; 2) a suggested clinical pathway; and 3) the creation of a community of practice. For the intervention, a contact nurse performed a clinical assessment, elicited patients' goals, and created an individualized care plan which constituted the suggested clinical pathway. Patients were then referred to the most appropriate professional(s) matching patient goals, including referrals to the nurses themselves. A final visit was with the contact nurse to summarize and plan for sustainability. More details are provided elsewhere.<sup>13,15</sup>

**Table 2.** Results for all participants 1 year after the intervention.

Mixed model analysis <sup>a</sup>	Diff. in mean <sup>b</sup>	95% CI <sup>c</sup>
<b>heiQ</b>	—	—
Health directed behaviour	0.10	−0.00–0.21
Positive and active engagement in life	−0.06	−0.12–0.00
Emotional wellbeing	0.10	0.01–0.20 <sup>†</sup>
Self-monitoring and insight	−0.01	−0.06–0.04
Constructive attitudes and approaches	−0.06	−0.13–0.01
Skill and technique acquisition	0.04	−0.03–0.12
Social integration and support	−0.01	−0.09–0.07
Health services navigation	−0.15	−0.21–−0.09 <sup>!</sup>
<b>Self-efficacy</b>	0.13	−0.06–0.32
<b>Veteran RAND-12 Health Survey (VR-12)</b>	—	—
Physical component	2.04	0.83–3.26 <sup>†</sup>
Mental component	1.83	0.53–3.12 <sup>†</sup>
<b>EuroQoL 5-domains questionnaire (EQ-5D)</b>	0.00	−0.015–0.019
<b>Generalized Linear Models<sup>a</sup></b>	OR <sup>§</sup>	95% CI
Presence of moderate to severe psychological distress (K6)	0.69	0.52–0.90 <sup>†</sup>
Participant with smoking habit	0.87	0.69–1.10
Practice of physical activity	1.17	0.87–1.57
Self-reported healthy eating	1.73	1.27–2.35 <sup>†</sup>
Having high risk of alcohol consumption	1.27	0.95–1.70

<sup>a</sup>Taking into account clustering within FMG. Adjusted for age, sex, income and number of chronic conditions.

<sup>b</sup>Differences in mean were calculated as: (after 1 year)–(baseline).

<sup>c</sup>95% CI: 95% Confidence Interval.

<sup>†</sup>Statistically significant; <sup>!</sup> Statistically significant deterioration.

<sup>§</sup>Odds ratios calculated comparing (after one year) to (baseline).

## Participants

Primary care patients between 18 and 80 years presenting three or more chronic conditions out of a list of 20<sup>16</sup> were referred by their primary care providers based on their clinical evaluation and need to receive the intervention. The choice of three or more chronic conditions likely better identifies patients with higher needs, and thus may be more meaningful than a count of two or more, which is less discriminating. To be recruited, patients had to be able to answer independently, able to speak French and to read the consent form.

## Study design

As mentioned earlier, all participants received the intervention and were combined into a single group for the purpose of this one-year post-intervention analysis, which used a pre-post study design.

## Outcomes

All outcomes were based on pretested and validated self-report questionnaires. They included the eight domains of the Health Education Questionnaire (heiQ),<sup>17,18</sup> the Self-Efficacy for Managing Chronic Diseases (SE-CD),<sup>19</sup> the

Veteran RAND-12 Health Survey (VR-12) with its physical and mental health components,<sup>20</sup> the EuroQoL 5-Domains questionnaire (EQ-5D),<sup>21</sup> The Kessler six item Psychological Stress Scale (K6)<sup>22–24</sup> and health behaviour assessments derived from the Enquête de Santé du Saguenay-Lac St-Jean 2007<sup>25</sup> and the Behavioural Risk Factor Surveillance System<sup>26</sup> which included measures of smoking habit, physical activity, healthy eating and alcohol consumption. Health behaviour variables were dichotomised as follows: tobacco smoking (yes or no), physical activity ('yes' if at least 20–30 min two or more times per week, 'no' if done less than 2 times a week), healthy eating ('yes' if good to excellent habits were self-reported, 'no' if bad to poor habits were self-reported). The criteria for classifying participants as having high risk alcohol consumption were the following: more than 10 standard drinks per week for women or more than 15 standard drinks per week for men,<sup>27</sup> and/or drinking alcohol four or more times in a week. The complete list of outcomes with psychometric properties is presented elsewhere.<sup>15</sup>

## Sample size and statistical power

Sample size and statistical power were calculated for the original trial. For this study, all participants were included in the analyses. Before conducting the subgroup analysis, we

**Table 3.** Subgroup results by age group 1 year after the intervention.

Mixed model analysis <sup>a</sup>	61 years or less <i>n</i> = 138		More than 61 years <i>n</i> = 146	
	Diff. in mean <sup>b</sup>	95% CI <sup>c</sup>	Diff. in mean	95% CI
<b>heiQ</b>	—	—	—	—
Health directed behaviour	0.23	0.08–0.38 <sup>†</sup>	–0.04	–0.19–0.11
Positive and active engagement in life	0.00	–0.08–0.09	–0.13	–0.22–0.04!
Emotional wellbeing	0.17	0.04–0.31 <sup>†</sup>	0.03	–0.10–0.17
Self-monitoring and insight	0.02	–0.05–0.09	–0.04	–0.12–0.04
Constructive attitudes and approaches	–0.01	–0.10–0.08	–0.12	–0.23–0.02!
Skill and technique acquisition	0.08	–0.02–0.18	0.01	–0.10–0.12
Social integration and support	–0.02	–0.13–0.08	0.01	–0.11–0.12
Health services navigation	–0.12	–0.20–0.04!	–0.19	–0.28–0.10!
<b>Self-efficacy</b>	0.14	–0.13–0.41	0.10	–0.17–0.38
<b>Veteran RAND-12 Health Survey (VR-12)</b>	—	—	—	—
Physical component	2.91	1.18–4.65 <sup>†</sup>	1.01	–0.70–2.73
Mental component	2.52	0.45–4.59 <sup>†</sup>	1.09	–0.44–2.63
<b>EuroQoL 5-Domains questionnaire (EQ-5D)</b>	0.01	–0.02–0.03	0.00	–0.02–0.02
<b>Generalized linear models<sup>a</sup></b>	OR <sup>§</sup>	95% CI	OR	95% CI
Presence of moderate to severe psychological distress (K6)	0.74	0.52–1.04	0.66	0.43–1.02
Participant with smoking habit	0.97	0.70–1.35	0.80	0.56–1.14
Practice of physical activity	1.31	0.84–2.05	0.10	0.67–1.49
Self-reported healthy eating	1.67	1.08–2.56 <sup>†</sup>	1.85	1.18–2.92 <sup>†</sup>
Having high risk of alcohol consumption	1.25	0.81–1.94	1.26	0.84–1.88

<sup>a</sup>Taking into account clustering within FMG. Adjusted for sex, income and number of chronic conditions.

<sup>b</sup>Differences in mean were calculated as: (after 1 year)–(baseline).

<sup>c</sup>95% CI: 95% Confidence Interval.

<sup>†</sup>Statistically significant; ! Statistically significant deterioration.

<sup>§</sup>Odds ratios calculated comparing (after one year) to (baseline).

calculated the statistical power for each variable. The power ranged from 0.057 to 0.998. The variables with low power in the subgroup analysis were self-monitoring and insight (0.077), social integration and support (0.057), and EQ-5D (0.078). The results for these variables in the subgroup analysis should be interpreted with caution.

The total number of patients lost to follow-up after 1 year was 76 (26.8%). A sensitivity analysis showed that there were no statistical differences in age, number of conditions, education, employment and income between the participants after 1 year and those who were lost to follow-up.

### Data analysis

We compared one-year results after the intervention with baseline using multilevel modelling. This allowed the use of partial data from subjects who did not complete all measurements. For the purpose of these analyses, each subscale was considered as a separate outcome measure, resulting in a total of 17 outcome measures (8 domains of the heiQ + 1 score of SE-CD + 2 components of VR-12 + 1 score of EQ-5D + 1 outcome for psychological distress, K6 + 4 outcomes of health behaviours). We used linear mixed model analysis (LMMA) taking into account clustering by FMG with SPSS MIXED

procedure which is a generalization of ANOVA for repeated measures for continuous variables, and generalized estimating equations models (GEEMs) which is a repeated logistic regression tool for dichotomous outcomes.<sup>28</sup> Both methods, generalized linear models and linear mixed regression models, retain all subjects with only one time data, and use all subjects with full data to estimate the mean for the missing values. Effect size was estimated with differences in mean and odds ratios (ORs) with their 95% confidence intervals. All analyses were performed using SPSS version 21 for Windows.

### Results

The trial originally recruited 284 participants from July 2016 to July 2017. Table 1 presents the characteristics of the participants. Mean age was 60.9 (±10.4 SD) years (median age 62; interquartile range = 13), and mean number of chronic conditions was 5.0 ± 1.8.

In the total sample, participants reported significantly improved outcomes for five measures (emotional wellbeing, VR-12 physical component, VR-12 mental component, moderate to severe psychological distress and healthy eating), and deterioration for one measure (Health services navigation) 1 year after the intervention, as reported in Table 2. Among the

**Table 4.** Subgroup results by number of chronic conditions 1 year after the intervention.

Mixed model analysis <sup>a</sup>	4 or less conditions		5 or more conditions	
	Diff. in mean <sup>b</sup>	95% CI <sup>c</sup>	Diff. in mean	95% CI
<b>heiQ</b>	—	—	—	—
Health directed behaviour	0.13	0.03–0.26	0.07	–0.10–0.25
Positive and active engagement in life	0.00	–0.08–0.08	–0.12	–0.21–0.02!
Emotional wellbeing	0.15	0.02–0.29	0.05	–0.08–0.17
Self-monitoring and insight	0.00	–0.08–0.07	–0.03	–0.10–0.05
Constructive attitudes and approaches	0.04	–0.05–0.13	–0.16	–0.27–0.05!
Skill and technique acquisition	0.12	0.02–0.22 <sup>†</sup>	–0.03	–0.13–0.08
Social integration and support	0.01	–0.09–0.11	–0.03	–0.15–0.09
Health services navigation	–0.10	–0.18–0.02!	–0.21	–0.30–0.13!
<b>Self-efficacy</b>	0.12	–0.12–0.36	0.14	–0.17–0.44
<b>Veteran RAND-12 Health Survey (VR-12)</b>	—	—	—	—
Physical component	3.12	1.48–4.77 <sup>†</sup>	1.07	–0.72–2.87
Mental component	1.45	–0.06–2.96	2.08	–0.02–4.174
<b>EuroQoL 5-Domains questionnaire (EQ-5D)</b>	0.01	–0.01–0.03	0.00	–0.028–0.026
<b>Generalized Linear Models<sup>a</sup></b>	OR <sup>§</sup>	95% CI	OR	95% CI
Presence of moderate to severe psychological distress (K6)	0.70	0.46–1.06	0.70	0.49–1.01
Participant with smoking habit	0.82	0.56–1.18	0.89	0.65–1.22
Practice of physical activity	1.10	0.68–1.76	1.28	0.89–1.84
Self-reported healthy eating	2.56	1.57–4.18 <sup>†</sup>	1.19	0.80–1.79
Having high risk of alcohol consumption	1.15	0.71–1.87	1.32	0.89–1.94

<sup>a</sup>Taking into account clustering within FMG. Adjusted for age, sex, and income.

<sup>b</sup>Differences in mean were calculated as: (after 1 year)–(baseline).

<sup>c</sup>95% CI: 95% Confidence Interval.

<sup>†</sup>Statistically significant; ! Statistically significant deterioration.

<sup>§</sup>Odds ratios calculated comparing (after 1 year) to (baseline).

eight domains of the heiQ only one, emotional wellbeing, improved significantly. Significant deterioration was observed for the Health services navigation domain. A small significant improvement in both physical and mental components of health status (VR-12 Health Survey) was observed, as well as a reduced presence of moderate to severe psychological distress (K6). Among the health behaviours, only healthy eating was improved.

Subgroup analysis revealed that the improvement in outcomes was not equally distributed (Tables 3–6). Among the eight domains of the heiQ, three showed some differential improvement according to the subgroups. Being younger (age 61 years or less) or having a higher income (50 US\$000 or more) were associated with greater improvements in health directed behaviour and emotional wellbeing domains. In addition to those two domains, the skill and technique acquisition domain was also improved in the subgroup with a lower number of chronic conditions (four or less). Responses to the intervention according to the heiQ did not differ by gender. All subgroups reported deterioration in the health services navigation domain.

Self-efficacy and quality of life, this latter measured by EQ-5D, did not vary over the 12 months of follow-up in any subgroup.

Both components (physical and mental) of health status, measured by the VR-12, improved in the younger subgroup, whereas neither component improved in the older age subgroup. A lower number of chronic conditions was associated with improvements of the physical component of the VR-12; there was no improvement for the subgroup with five or more conditions. People with lower income improved both components of the VR-12, whereas a higher income was associated with improvement of the physical component, but not the mental one. Both males and females improved the physical component of the VR-12 but only females improved the mental component. Scores were lower for both components at baseline in females compared to males (38.4 vs 41.8,  $P = 0.007$  for the physical component; and 52.5 vs 56.0,  $P = 0.005$  for the mental component).

Healthy eating was reported as improved in both age groups, patients with lower number of chronic conditions, higher income and males.

**Table 5.** Subgroup results by sex 1 year after the intervention.

Mixed model analysis <sup>a</sup>	Males		Females	
	Diff. in mean <sup>b</sup>	95% CI <sup>c</sup>	Diff. in mean <sup>b</sup>	95% CI
<b>heiQ</b>	—	—	—	—
Health directed behaviour	0.10	−0.06–0.25	0.11	−0.04–0.27
Positive and active engagement in life	−0.06	−0.14–0.02	−0.05	−0.14–0.04
Emotional wellbeing	0.08	−0.05–0.21	0.13	−0.01–0.26
Self-monitoring and insight	−0.02	−0.09–0.06	−0.01	−0.08–0.07
Constructive attitudes and approaches	−0.06	−0.16–0.03	−0.07	−0.17–0.04
Skill and technique acquisition	0.06	−0.05–0.16	0.03	−0.07–0.14
Social integration and support	−0.05	−0.16–0.068	0.02	−0.08–0.13
Health services navigation	−0.14	−0.23–0.05!	−0.17	−0.26–0.09!
<b>Self-efficacy</b>	−0.01	−0.26–0.25	0.25	−0.04–0.54
<b>Veteran RAND-12 Health Survey (VR-12)</b>	—	—	—	—
Physical component	1.48	0.04–2.92 <sup>†</sup>	2.56	0.64–4.48 <sup>†</sup>
Mental component	1.50	−0.14–3.15	2.10	0.12–4.07 <sup>†</sup>
<b>EuroQoL 5-domains questionnaire (EQ-5D)</b>	0.00	−0.02–0.03	—	−0.026–0.026
<b>Generalized Linear Models<sup>a</sup></b>	OR <sup>§</sup>	95% CI	OR	95% CI
Presence of moderate to severe psychological distress (K6)	0.64	0.40–1.05	0.72	0.51–1.01
Participant with smoking habit	0.85	0.60–1.21	0.90	0.64–1.25
Practice of physical activity	0.91	0.58–1.42	1.43	0.94–2.17
Self-reported healthy eating	2.25	1.40–3.62 <sup>†</sup>	1.40	0.93–2.11
Having high risk of alcohol consumption	1.14	0.87–1.51	1.28	0.85–1.94

<sup>a</sup>Taking into account clustering within FMG. Adjusted for age, income and number of chronic conditions.

<sup>b</sup>Differences in mean were calculated as: (after 1 year)–(baseline).

<sup>c</sup>95% CI: 95% Confidence Interval.

<sup>†</sup>Statistically significant; ! Statistically significant deterioration.

<sup>§</sup>Odds ratios calculated comparing (after one year) to (baseline).

## Discussion

We observed improvements in five out of the 17 outcomes measured 1 year following a multipronged interdisciplinary patient-centred intervention for people with three or more chronic conditions. Subgroup analyses according to sex, age, number of chronic conditions and income showed that improvements were not equally distributed among the groups. Domains of the heiQ that did not improve for the whole group did improve in some subgroups. Particularly, the health directed behaviour improved in the younger subgroup, in those with higher income, and in patients with four or less conditions. In patients with four or less conditions, skill and technique acquisition also improved. However, the magnitude of the changes is small and their clinical significance is unclear. The heiQ is an instrument designed for the comprehensive evaluation of patient education programmes.<sup>18</sup> However, the benchmark sizes proposed for changes in heiQ scores were not for clinical relevance.<sup>29</sup> Therefore, the clinical relevance of the improvements found is uncertain, which is a problem also noted by others.<sup>30</sup> Subgroup analyses are rarely conducted in studies on interventions for multimorbidity which limits our ability to compare results with others.<sup>12</sup>

If we balance the number of improvements versus the number of deteriorations or neutral effects for all the outcomes, patients below the age of 61, with a lower number of chronic conditions, and with higher income emerge as being more likely to benefit from this type of intervention than other subgroups. This suggests that interventions should be tailored according to patients' characteristics to promote greater effectiveness by intensifying actions for the more vulnerable patient groups being older, with more than four chronic conditions and with lower income.

In comparison with results of the four-month original RCT,<sup>15</sup> the one-year follow-up for the entire sample analysis leads to essentially the same results for the heiQ domains and the Self-Efficacy for Managing Chronic Disease (SE-CD), where only one domain of the heiQ showed an improvement. Similarly, the healthy eating improvement observed in the intervention group of the RCT is still observed after 1 year for the whole group. However, physical activity which improved in the intervention group of RCT after 4 months was not maintained as an improvement after 1 year in the whole group. Motivation is a crucial factor in maintaining physical activity.<sup>31</sup> However, motivation for participation in physical activity is different across type of activity, age and gender in adults.<sup>31</sup> Additional efforts



**Table 6.** Subgroup results by income group 1 year after the intervention.

Mixed model analysis <sup>a</sup>	Income less than 50 US\$000		Income 50 US\$000 or more	
	Diff. in mean <sup>b</sup>	95% CI	Diff. in mean	95% CI
Health directed behaviour	0.05	-0.10-0.20	0.18	0.03-0.33 <sup>†</sup>
Positive and active engagement in life	-0.12	-0.21-0.04!	0.02	-0.06-0.11
Emotional wellbeing	0.02	-0.11-0.15	0.21	0.06-0.36 <sup>†</sup>
Self-monitoring and insight	-0.02	-0.09-0.06	0.00	-0.077-0.079
Constructive attitudes and approaches	-0.12	-0.22-0.03!	0.02	-0.09-0.11
Skill and technique acquisition	0.000	-0.103-0.102	0.10	-0.01-0.20
Social integration and support	-0.03	-0.15-0.08	0.02	-0.08-0.13
Health services navigation	-0.20	-0.28-0.11!	-0.10!	-0.19-0.02
Self-efficacy	0.08	-0.20-0.36	0.19	-0.06-0.45
VR-12 physical component	1.96	0.24-3.68 <sup>†</sup>	2.14	0.42-3.86 <sup>†</sup>
VR-12 mental component	2.49	0.64-4.35 <sup>†</sup>	1.01	-0.77-2.78
EQ-5D	0.01	-0.01-0.03	-0.01	-0.03-0.01
<b>Generalized Linear Models<sup>a</sup></b>	<b>OR<sup>§</sup></b>	<b>95% CI</b>	<b>OR</b>	<b>95% CI</b>
Presence of moderate to severe psychological distress (K6)	0.66	0.47-0.93 <sup>†</sup>	0.71	0.45-1.12
Participant with smoking habit	0.88	0.74-1.04	1.15	0.77-1.71
Practice of physical activity	1.07	0.74-1.54	1.26	0.77-2.07
Self-reported healthy eating	1.16	0.79-1.70	2.61 <sup>†</sup>	1.61-4.24
Having high risk of alcohol consumption	1.07	0.82-1.39	1.58	0.95-2.63

<sup>a</sup>Taking into account clustering within FMG. Adjusted for age, sex, and number of chronic conditions.

<sup>b</sup>Differences in mean were calculated as: (after 1 year)-(baseline).

<sup>c</sup>95% CI: 95% Confidence Interval.

<sup>†</sup>Statistically significant; ! Statistically significant deterioration.

<sup>§</sup>Odds ratios calculated comparing (after one year) to (baseline).

including the use of behaviour change techniques<sup>32</sup> should therefore be made for long-term maintenance of patients' motivation for physical activity. Some outcomes that did not significantly improve after 4 months in the RCT were improved after 1 year in the whole group. For example, both physical and mental VR-12 health status components statistically improved. However, these improvements of less than five points are not considered clinically significant.<sup>33,34</sup> Also, the proportion of subjects with moderate to severe psychological distress decreased significantly. We consider that these are promising findings. The value of a one-year follow-up (versus a shorter follow-up) is highlighted by these findings.

Analysis of the results by subgroup in the present study provides suggestions for the redesign of future interventions. A comparative analysis of the two age groups showed that there were no differences in the sex distribution, but the older group had a lower income and more chronic conditions. In comparison with patients 61 years or younger who showed improvements in multiple outcomes, only one outcome (healthy eating) improved in the older group. This may reflect better learning capacity, adaptation skills, or motivation in the younger group. It could also mean that we must better adapt the intervention to the age of the patient. This result is consistent with subgroup analyses from a small RCT evaluating a group-based self-management

programme for patients with multimorbidity in which younger patients obtained better outcomes.<sup>35</sup>

In the groups divided according to the number of chronic conditions, there were more female subjects, participants were older, and had a lower income in the group with five or more conditions. None of the outcomes improved in the group with five or more chronic conditions. Many elements could be contributing to this, including greater complexity, more confusion among recommendations, more interaction among conditions, difficulty with motivation and resistance to more change in the patients' life.<sup>36</sup> The treatment burden, already high in this group, may limit the potential for improvement.<sup>37</sup> Goals may not have been clearly identified in the individualized care plan created by the contact nurse.<sup>15</sup> Interventions with closer monitoring may be required and should be tested in future studies among this subgroup. We found only one multimorbidity intervention study that analysed outcomes according to the number of chronic conditions and reported a neutral effect on health-related quality of life which is at variance with our analyses.<sup>35</sup>

Comparing groups with different income, we observed that in the lower income group none of the heiQ domains improved nor did any health behaviour. We can hypothesize that financial constraints act as a barrier to improvement, which represents an issue of equity.<sup>38</sup> Our income subgroup results are consistent with those of several other studies that

failed to improve outcomes among patients with multimorbidity and low income.<sup>39–41</sup> This highlights that further considerations regarding the possible role of income are required when developing interventions for patients with multimorbidity. This way, the design of interventions should take into account patients' income and adapt the intervention plan accordingly. The aspect of out of pocket money should be discussed with the patient to determine how it could affect his/her adherence to intervention recommendations.

Both physical and mental VR-12 health status components showed a tendency to improvement after 1 year, regardless of gender. However, whereas changes in both components were significant in the female group, the improvement in the mental component did not reach significance in males, which may be due to the size of the sample.

Previous studies have shown that women usually attach greater importance to healthy eating than men.<sup>42,43</sup> This is at variance with our results showing a significant change in healthy eating habit after the intervention in males but not in females despite similar proportion of this behaviour at baseline.

A strength of this study is that analyses took into account clustering within FMG and potential confounding through multivariate analyses. This study has some limitations. Rather than having identified primary and secondary outcomes a priori, as we did for the RCT, we used the proportion of outcomes that showed improvements either for the group as a whole, or for subgroups. This post hoc definition of the outcome should be viewed more exploratory like the focus more on the statistical than the clinical significance. These analyses were conducted to help guide future development of interventions for patients with multimorbidity.

As no control group was used with the pre-post design, we cannot conclude on the effectiveness of the intervention after 1 year. However, the subgroup analyses results have the potential to inform further development in multimorbidity interventional research. As with the original RCT,<sup>15</sup> we observed relatively few outcomes that improved as a result of the intervention and the question remains as to whether there was little effect or whether measures were sufficiently sensitive to document the effects of the intervention. The data collected for the study were self-reported and the presence of a social desirability bias cannot be excluded. The loss to follow-up, not unusual in real world studies, may have introduced a selection bias and is also one of the reasons for which the analysis is considered as exploratory. Finally, with the number of outcomes considered, there is an increased probability that some of the statistically significant changes may have happened by chance.

## Conclusion

One year after a patient-centred interdisciplinary care intervention for multimorbidity, outcomes in the overall sample

showed some differences between the results observed in the intervention group of RCT after 4 months and 1 year after both groups received the intervention. These results may inform us about outcomes in which more efforts should be made to sustain improvements over longer periods.

Subgroup analyses in this exploratory study suggest that younger patients, those with lower number of chronic conditions or higher incomes may respond better in relation to self-management, health status and health behaviours. These results suggest that future interventions should be tailored to patients' characteristics to improve outcomes among persons with multimorbidity.

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## ORCID iDs

Martin Fortin  <https://orcid.org/0000-0002-9874-3771>.

Bridget L Ryan  <https://orcid.org/0000-0001-9080-5635>.

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