Activity-Modifying Behaviour Mediates the Relationship between Pain Severity and Activity Limitations among Adults with Emergent Knee Pain

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ABSTRACT

Purpose: To determine whether activity-modifying behaviour mediates the relationship between the severity of knee pain and each of physical function and knee-related quality of life. **Methods:** A total of 105 participants with medial knee pain and no diagnosis of knee osteoarthritis (mean age 52.2 [SD 6.7] y) completed two self-report questionnaires. The Questionnaire to Identify Knee Symptoms assessed activity-modifying behaviour; the Knee Injury and Osteoarthritis Outcome Score assessed pain severity, physical function, and knee-related quality of life. Simple mediation analysis was performed using linear regression. **Results:** The unstandardized regression coefficient for activity-modifying behaviour revealed partial mediation of the effect of pain severity on physical function (0.31 (SE 0.09), $p < 0.001$) and on knee-related quality of life (0.24 (SE 0.07), $p < 0.001$). After accounting for activity-modifying behaviour, the variance in physical function that was explained by pain decreased from 45% to 15%, and the variance in knee-related quality of life that was explained by pain decreased from 64% to 25%. **Conclusion:** Activity-modifying behaviour partially mediates the relationship between pain severity and physical function and between pain severity and knee-related quality of life. Activity-modifying behaviour may thus counteract the impact of knee pain on physical function and knee-related quality of life, which explains why it is used by people with emergent knee pain.

Key Words: behaviour; arthralgia; knee; activities of daily living; quality of life.

RÉSUMÉ

Objectif : Déterminer si un comportement modifiant les activités peut influencer sur la relation entre la sévérité d'une douleur au genou et chacune des fonctions physiques et la qualité de vie associée au genou. **Méthode :** Au total, 105 participants avec douleur au genou interne et aucun diagnostic d'arthrose du genou (âge moyen de 52,2 ans; écart type de 6,7 ans) ont rempli deux questionnaires d'auto-évaluation. Le questionnaire pour déterminer les symptômes au genou (*Questionnaire to Identify Knee Symptoms*, QulKS) visait à évaluer les comportements qui modifient les activités; le pointage obtenu au questionnaire sur les blessures au genou et l'arthrose (*Knee injury and Osteoarthritis Outcome Score*, KOOS) permettait d'évaluer la sévérité de la douleur, la fonction physique et la qualité de vie associée au genou. Une analyse de médiation simple a été réalisée à l'aide d'un modèle de régression linéaire. **Résultats :** Le coefficient de régression non normalisé ($\pm$ erreur type) du comportement modifiant l'activité a révélé une réduction partielle de l'effet de la sévérité de la douleur sur la fonction physique ($0,31 \pm 0,09$, $p < 0,001$) et sur la qualité de vie associée au genou ($0,24 \pm 0,07$, $p < 0,001$). Après la mise en place d'un comportement modifiant l'activité, la variation de la fonction physique causée par la douleur est passée de 45 % à 15 %, et la variation dans la qualité de vie associée au genou provoquée par la douleur est passée de 64 % à 25 %. **Conclusion :** Un comportement qui modifie l'activité réduit partiellement la relation entre la sévérité de la douleur et la fonction physique et entre la sévérité de la douleur et la qualité de vie associée au genou. On a donc recours à une modification de l'activité chez les personnes aux prises avec une douleur émergente au genou, et cette modification pourrait contrer les effets de la douleur au genou sur la fonction physique et sur la qualité de vie.

Knee osteoarthritis (OA) is a degenerative joint disease characterized by progressive deterioration of articular cartilage, subchondral bone, and other joint tissues.¹ In

many cases, OA results in progressive pain and activity limitations.¹ While OA is considered the most common cause chronic knee pain, little evidence exists of an

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association between radiographic signs of joint degradation in knee OA and self-reported symptoms.² Instead, the interplay of pain severity with behavioural and psychosocial factors likely captures more variation in activity limitations.^{3–6} Interestingly, “preclinical disability” was detected among 436 community-dwelling older women with or without knee OA using self-report and physical performance measures,⁷ a finding that highlights the potential for self-reported pain severity to predict future activity limitations.⁸ In established knee OA, many risk factors for progressive disability have been identified, including obesity and knee malalignment.¹ However, much less is known about the biopsychosocial mechanisms underlying increasing limitations in function and worsening quality of life (QOL) in people who may have preclinical or early symptomatic knee OA.

The process of recognizing the early experiences associated with chronic knee problems has been described in a conceptual model⁵ suggesting that early recognition of chronic knee problems involves activity-modifying behaviour (AMB)—the activity-based strategies people use to avoid progressive knee damage. These behaviours fall into several categories: limiting involvement in physical activities because of lost knee functional capacity—for example, stopping an activity (selection); continuing activity by enhancing one’s resources to avoid aggravating the knee/s (optimization); and using new ways to achieve goals (compensation).⁹ Even before reporting difficulty with tasks, people with chronic knee pain may respond to early limitations in activity by adjusting their behaviour during these activities.⁷ Therefore, it is reasonable to hypothesize that these behaviours may be associated with changes in physical function (PF) and knee-related quality of life (KR-QOL). The purpose of our study was to examine whether, among people with emergent chronic knee pain problems, AMB acts as a mediator for the relationships between severity of knee pain and each of PF and KR-QOL. A mediator is a factor representing a mechanism whereby an independent variable can influence a dependent variable of interest.¹⁰ We hypothesized that AMB is a mechanism through which pain severity influences PF and KR-QOL among adults with emergent knee problems.

METHOD

Participants

Invitations to participate were sent to 228 community-dwelling adults (age 40–65 y) who had reported knee pain within the past 3 years to any of 6 general practitioners at a university-affiliated medical clinic located in south-western Ontario, Canada. The Health Sciences Research Ethics Board of the University of Western Ontario approved the study, and all participants provided informed consent. Participants had a history of knee pain lasting ≥ 2 weeks and no clinical or radiological diagnosis of

knee OA. People with gout, rheumatoid arthritis, chronic low back pain, foot or hip pain, major comorbidities, knee replacement, or high tibial osteotomy were excluded. Of the 228 invitations, 49 potential participants were ineligible (e.g., no current knee pain) and another 72 were non-respondents (i.e., explicitly opted out or did not reply). The response rate for completed questionnaires was 60%. After excluding data from another two people for $\geq 10\%$ missing data, we had data from 105 eligible participants to use for analysis.

Procedure

Our study used a cross-sectional design. Participants received by mail and completed two questionnaires: the Knee Injury and Osteoarthritis Outcome Score (KOOS) and the Questionnaire to Identify Knee Symptoms (QuIKS).^{11,12} The KOOS is a 42-item knee-specific self-administered questionnaire consisting of five sub-scales: pain, other symptoms, function in activities of daily living, function in sport and recreation, and KR-QOL. Each item is measured on a 5-point adjectival scale from 0 to 4; each sub-scale is scored by summing the item responses and transforming the total to a scale from 0 (worst state) to 100 (best state).¹³ KOOS data have demonstrated validity, reliability, and responsiveness with various types of knee problems, including OA.⁵ The QuIKS is a 13-item self-administered questionnaire reflecting the challenges and experiences of people with undiagnosed or recently diagnosed radiographic knee OA.⁵ The items were validated using an independent sample of people with knee-pain problems but no clinical or radiological knee OA.¹² Developed from the patient’s perspective, the QuIKS consists of four separately scored sub-scales: medications, monitoring, interpreting, and modifying. These sub-scales have good internal consistency reliability,¹⁵ with Cronbach’s alpha values of 0.82, 0.83, 0.73, and 0.87 respectively.¹²

Measures

Independent (predictor) variable

Severity of knee pain experienced during the last 2 weeks was quantified using the KOOS pain sub-scale.

Proposed mediator

Activity-modifying behaviour (AMB) was assessed using the QuIKS modifying sub-scale, which consists of three items: “I participate in certain activities less often to avoid aggravating my knee”; “I am considering stopping my favorite activities because of my knee(s)”; and “I am considering changing my exercise routine due to my knee problems.” Each item is measured on a 5-point Likert-type scale (0 = strongly disagree, 4 = strongly agree); these values are summed, and the sub-scale score is then reversed and transformed to a score out of 100. Scores closer to 0 indicate more agreement that one is considering or already modifying activities in response to knee pain.

Figure 1 Analytical diagram of the proposed simple mediation models

*Knee-pain severity (independent variable).

†Physical function (dependent variable: pain severity and physical function mediation model).

‡Knee-related quality of life (dependent variable: pain severity and knee-related quality of life mediation model).

§Activity-modifying behaviour (proposed mediator).

Note: Unstandardized regression coefficients are c = total effect of knee-pain severity on physical function or knee-related quality of life; a = effect of knee-pain severity on activity-modifying behaviour; b = direct effect of activity-modifying behaviour on physical function or knee-related quality of life; and c' = direct effect of knee-pain severity on physical function or knee-related quality of life.

Dependent variables

The KOOS sport and recreation function and KR-QOL sub-scales were used to quantify PF and KR-QOL respectively. The 5-item KOOS sport and recreation function sub-scale assesses function at a higher degree than the ability to move around and look after oneself; for example, it includes an item on difficulty with running. The 4-item KOOS KR-QOL sub-scale captures knee-related aspects of QOL with questions such as “In general, how much difficulty do you have with your knee?”¹³

Statistical analysis

We first eliminated questionnaires with missing items from the QuIKS modifying sub-scale, the KOOS pain sub-scale, or the KOOS sport and recreation function or KR-QOL sub-scales from our data set. We then assessed normality of distribution for each sub-scale, using the Kolmogorov–Smirnov Z test.¹⁵ To validate the AMB measure, we calculated Pearson correlation coefficients to examine the relationship between the QuIKS modifying sub-scale and each of the KOOS sub-scales.¹⁵ Internal construct validity of AMB was assessed using Rasch analysis,¹⁶ to confirm that a single construct underlies what the QuIKS modifying sub-scale claims to measure. The Rasch Partial Credit Model criteria for unidimensionality were used.¹⁷ The KOOS sport and recreation function sub-scale inquires about degree of difficulty, and the KOOS KR-QOL sub-scale asks about modifying activity and difficulty; because study participants may not have viewed these concepts as distinct from the concepts measured by the QuIKS modifying sub-scale, we entered the AMB items together with the KOOS sport and recreation function items (and then with the KOOS KR-QOL

items) in the Rasch analysis to assess relative item hierarchy on the same logit scale. Rasch analysis was performed using the software RUMM2030 (Andrich and colleagues, RUMM Laboratory, Perth, Western Australia).

Two separate analyses aimed to identify whether AMB mediated the relationship between pain severity and PF or between pain severity and KR-QOL in our sample. Removing missing values resulted in different sample sizes for each of these models. We used a one-sample t -test and chi-square test to compare the total sample to each of the two mediation model samples.¹⁵ Figure 1 shows the analytical model used to determine whether AMB mediated the impact of pain severity on PF. This model shows that for AMB to act as a mediator, a significant relationship between pain severity and PF must be reduced when AMB is accounted for as a covariate. The first step was a simple linear regression to identify whether pain severity was related to PF (see Figure 1a, where c is the unstandardized regression coefficient, symbolizing the total effect of knee pain severity on PF). Second, two linear regressions established that pain severity was related to AMB (coefficient a in Figure 1b) and AMB was related to PF (coefficient b in Figure 1b). The third step was to evaluate the relationship between pain severity and PF using a linear regression, controlling for the proposed mediator, AMB. Here, coefficient c' symbolizes the direct effect of knee-pain severity on PF or on KR-QOL, after adjusting for the proposed mediator-AMB (path c'). An indirect effect is the product of the unstandardized regression coefficients a and b , termed path ab (equivalent to $c - c'$).¹⁸ If this final regression equation was not significant, the Sobel equation was used to examine partial mediation.^{18,19} Briefly, this test generates a point estimate of the potential mediating effect of path ab ; using $N = 5,000$ bootstrap resamples corrected for distribution bias and skewness, it generates a 95% bias-corrected and accelerated (BCa) confidence interval (CI).²⁰ When the BCa CI did not include zero, the presence of a mediator was confirmed.

We used the Sobel test because it has more statistical power and lower probability of Type 1 errors than other methods of assessing mediation,²¹ and bootstrapping because the distribution of a significant indirect effect is usually non-symmetric, and this nonparametric resampling procedure does not rely on normal distributions; it also allows for non-symmetric confidence limits around the estimated indirect effect.²² BCa CIs are superior to symmetric CIs, with respect to both Type I error rates and power, when estimating indirect effects with small to moderate-sized samples in mediation models.¹⁸ These BCa CIs retain the desired property of robustness and do not produce excessively wide limits.²⁰ Our descriptive and mediation analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 17.0 for Windows (SPSS Inc., Chicago, IL).

Table 1 Characteristics of Study Participants by Total Sample and Mediation-Model Sample

Characteristic	Group; no. (%) of participants*		
	Total <i>n</i> = 105	Mediation model	
		Pain and PF <i>n</i> = 84	Pain and KR-QOL <i>n</i> = 91
Age, y; mean (SD)	52.2 (6.7)	52.1 (6.9)	52.2 (6.7)
BMI, kg/m ² ; mean (SD)	27.6 (5.5)	27.5 (5.4)	27.7 (5.5)
Female sex	59 (56.2)	43 (51.2)	49 (53.8)
Bilateral knee complaints	46 (43.8)	40 (47.6)	43 (47.3)
Family history of arthritis	53 (51.5)	38 (45.2)†	43 (47.3)†
History of knee problems	76 (72.4)	63 (75.0)	69 (75.8)
Previous knee injury	45 (42.6)	37 (44.0)†	41 (45.1)†

*Unless otherwise indicated.

†Different from total sample at $p < 0.05$.

PF = physical function; KR-QOL = knee-related quality of life; BMI = body mass index.

RESULTS

Participant characteristics for the total sample ($n = 105$) and for the samples used in each mediation model are given in Table 1. Because some participants did not respond to all KOOS items, the sizes of the two mediation models (pain and PF, $n = 84$; pain and KR-QOL, $n = 91$) differed from the total sample. As Table 1 shows, this affected two study variables. Compared to the total sample, the mediation model using PF as the dependent variable had 5.1% fewer people with a family history of arthritis ($\chi^2 = 5.13$, $df = 1$, $p = 0.023$) and 1.4% more people with a previous knee injury ($\chi^2 = 4.04$, $df = 1$, $p = 0.045$). Compared to the total sample, the mediation model using KR-QOL as the dependent variable had 3.7% fewer people with a family history of arthritis ($\chi^2 = 8.68$, $df = 1$, $p = 0.003$) and 2.5% more people with a previous knee injury ($\chi^2 = 4.24$, $df = 1$, $p = 0.030$). Table 2 gives descriptive statistics and bivariate correlations for the

mediation model variables. We found strong positive correlations among AMB, knee pain severity, PF, and KR-QOL ($p < 0.001$).²³ In both models, the majority (92.7%) of participants reported some pain (5.6–97.2 KOOS units). The ceiling and floor effects of the AMB scale were the same for both models and acceptable, at 2.9% and 11.4% respectively. The Kolmogorov–Smirnov Z test revealed normal distributions for the QuIKS modifying sub-scale, the KOOS pain, KOOS sport and recreation function, and KOOS KR-QOL sub-scales ($p > 0.05$).

The Rasch analysis demonstrated that the AMB measure was unidimensional, with a non-significant item–trait interaction ($\chi^2 = 1.29$, $df = 3$, $p = 0.73$). Each item had properly ordered category thresholds. The item and person standardized residuals all fell within the criterion value of ± 2.5 . There was no local dependency of items (i.e., response to one item did not influence response to another item). Mathematical removal of the AMB latent

Table 2 Descriptive Statistics and Bivariate Correlations among Mediation Model Variables

Study variable	Sub-scale score; mean (SD)	Correlation*		
		AMB	Pain severity†	PF
Proposed mediator AMB; $n = 105$	57.1 (27.4)	–	–	–
Independent variable Pain severity‡; $n = 91$	77.0 (18.3)	0.541	–	–
Dependent variables PF‡; $n = 93$	68.7 (25.7)	0.646	0.699	–
KR-QOL‡; $n = 99$	63.8 (21.4)	0.699	0.801	0.769

*Pearson correlation coefficients: all $p < 0.001$.

†Knee-pain severity, KOOS pain sub-scale.

‡0 = worst state, 100 = best state.

AMB = activity-modifying behaviour (0–100 represents more to less agreement that one is considering or already modifying activities in response to knee pain); PF = physical function (KOOS sport and recreation function sub-scale); KR-QOL = knee-related quality of life (KOOS knee-related quality of life sub-scale); KOOS = Knee injury and Osteoarthritis Outcome Score.

Figure 2 Unstandardized regression coefficients and r -squared values for the pain severity and physical function mediation model.

*Knee-pain severity (independent variable).

†Physical function (dependent variable).

‡Activity-modifying behaviour (mediator).

Note: (a) Total effect of knee-pain severity on physical function (path c); (b) Mediation pathway of activity-modifying behaviour between knee-pain severity (path a) and physical function (path b).

Figure 3 Unstandardized regression coefficients and r -squared values for the pain severity and knee-related quality of life mediation model.

*Knee-pain severity (independent variable).

†Knee-related quality of life (dependent variable).

‡Activity-modifying behaviour (mediator).

Note: (a) Total effect of knee pain severity on knee-related quality of life (path c); (b) Mediation pathway of activity-modifying behaviour between knee-pain severity (path a) and knee-related quality of life (path b).

trait from the item–trait interaction left behind residuals. Principal-components analysis of these residuals identified two subsets of items, based on whether the item loaded positively or negatively on the first principal component. Each of these two subsets estimated the level of AMB for each person. The results of an independent t -test ($p < 0.05$) comparing these estimates suggested that the AMB measure is unidimensional.

Item characteristics curves revealed good fit of the items to the Rasch model. Results indicated no differential item functioning by any participant characteristic, meaning that responses to each item of the AMB measure did not differ on the basis of participant characteristics (e.g., between male and female participants). Reliability (internal consistency), assessed by the person separation index, was 0.76, which indicates that the scale was reliable when comparing two discrete groups on the study trait. On a single logit scale, 4 of 5 KOOS sport and recreation function items and 3 of 4 KOOS KR-QOL items captured a higher level of the study trait than the AMB items. Across both analyses, the AMB items consistently captured a lower level of the study trait than the KOOS items did, which indicates the AMB items' ability to capture behaviour change versus the level of difficulty performing a given activity.

Pain and PF mediation model

Figure 2 shows the unstandardized regression coefficients from the mediation analysis of pain severity and PF. In Figure 2a, the coefficient indicates that a 1-unit change in pain severity corresponded to a similar (0.99-unit) change in KOOS sport and recreation function. Overall, pain severity explained 48% of the variance in PF ($p < 0.001$). In Figure 2b, path a shows that pain severity had a positive effect on AMB ($p < 0.001$); furthermore, AMB had a positive effect on PF (path b ,

$p < 0.001$). The effect of pain severity (path c') on PF after adjusting for AMB was also significant ($p < 0.001$). The effect of pain severity on PF was not fully reduced by AMB (path ab) but maintained a significant ($p < 0.001$) positive direct effect (Figure 2, path c vs. path c'). These findings demonstrate that AMB partially mediated the relationship between pain severity and PF. The AMB-mediated effect, estimated by the unstandardized regression coefficient was 0.31 (SE 0.09) ($p < 0.001$; 95% BCa CI, 0.16–0.52 KOOS sport and recreation function units). Finally, pain severity explained 15% of the variance in PF after adjusting for AMB. Thus, the mediating effect of AMB accounted for 33% of the variance in PF.

Pain and KR-QOL mediation model

In Figure 3a, the unstandardized regression coefficient indicates that a 1-unit change in pain severity corresponded to a similar (0.95-unit) change in KOOS KR-QOL. Overall, in the KR-QOL model, pain severity explained 64% of the variance in KR-QOL ($p < 0.001$). Path a in Figure 3b shows that pain severity had a positive effect on AMB ($p < 0.001$); furthermore, AMB had a positive effect on KR-QOL (path b , $p < 0.001$). The direct effect of pain severity (path c) on KR-QOL after adjusting for AMB was significant ($p < 0.001$). The effect of pain severity on KR-QOL was not fully reduced by accounting for AMB but maintained a significant ($p < 0.001$) positive direct effect on KR-QOL (Figure 3, path c vs. path c'). These findings demonstrate that AMB partially mediated the relationship between pain severity and KR-QOL. The AMB-mediated effect, estimated by the unstandardized regression coefficient was 0.24 (SE 0.07) ($p < 0.001$; 95% BCa CI, 0.13–0.39 KOOS KR-QOL units). Finally, pain severity explained 25% of the variance in KR-QOL after adjusting for AMB. Thus, the mediating effect of AMB accounted for 39% of the variance in KR-QOL.

DISCUSSION

Our findings demonstrate that AMB partially mediated the effect of knee-pain severity on both PF and on KR-QOL. Our hypotheses were supported, which suggests that behaviours that modify activity limitations can attenuate both the severity of knee pain and limitations in PF and KR-QOL for middle-aged adults with knee-pain problems before a diagnosis of knee OA.

An increase in pain severity was associated with almost the same magnitude of deterioration on the KOOS sport and recreation function sub-scale; AMB mediated nearly one-third of this change and accounted for 33% of the variation in PF. The mediation mechanism is not clear from the current study, but one mechanism that may explain how AMB mediates the association between pain severity and PF can be found in a conceptual framework developed from the avoidance model.²⁴ When pain is interpreted as a threat, people modify or adapt their engagement in physical activities that trigger pain, as a coping mechanism to avoid experiencing or increasing pain.^{3,4,24} Such AMB can be adaptive in the short term (i.e., pain is initially decreased)^{24,25} but may be maladaptive in the long term (i.e., muscle strength and joint stability diminish over time because of low activity levels).^{24,25} A further explanation lies in the cross-sectional study by Steultjens and colleagues, who found that muscle strength mediated the avoidance behaviour–PF relationship in people with symptomatic knee OA.⁴ The fear-avoidance model of musculoskeletal pain suggests that AMB may be reflected in submaximal performance of activities by people with chronic pain: chronic pain may be unavoidable, but activities perceived as a threat are avoided to prevent an increase in pain or (re-)injury.²⁵ Thus, both physiologic (e.g., strength) and psychological (i.e., behavioural) factors may underlie the role played by AMB in mediating the relationship between pain severity and PF in our study. Future research should identify to what extent AMB is adaptive or maladaptive.

Similarly, an increase in pain severity was associated with almost the same magnitude of deterioration on the KOOS KR-QOL sub-scale; AMB mediated nearly one-quarter of this change and accounted for 39% of the variance in KR-QOL. Using the same measures, previous studies have shown that worse pain-severity scores are related to worse KOOS KR-QOL scores. For example, young amateur football players (mean age 21.6 y) with no history of knee injury had significantly lower self-reported pain severity and KR-QOL than those with a history of severe knee injury.²⁶ Also, middle-aged patients (mean age 52.6 y) who received meniscectomy had worse pain severity and KR-QOL scores 18 years after surgery than a population-based group of healthy controls.²⁷ The mechanism underlying changes in KR-QOL may differ from that of PF; it has been suggested that QOL may

improve once appropriate pain coping strategies are employed.³

In the current study, participants were people who had identified ongoing knee problems, including pain, to their general practitioners, which suggests they may have been experiencing difficulties in performing tasks that are important to them.⁵ The mean total scores on the KOOS pain severity, KOOS sport and recreation function, and KOOS KR-QOL variables in the current study were worse than those of older adults in a population-based reference group study²⁸ but better than pre-surgery scores of older adults who underwent high tibial osteotomy for symptomatic knee OA.²⁹ Furthermore, the mean total score on these variables were better than those reported by older adults 18 years post meniscectomy but similar to scores reported at 25 years post meniscectomy.²⁷ These comparisons support the sample construct validity, since the knee status of study participants (emergent chronic knee pain) was worse than that of the average older adult but better than that of people with advanced symptomatic knee OA.

The relatively wide CIs of the mediated effects likely reflect the variability of the self-reported AMB scale scores, which may indicate differences in how participants approached activity modification in response to their knee pain. Before tasks become increasingly difficult to perform, an AMB strategy enables people to maintain function without a sense of change in task difficulty.³⁰ In the early stages of decline, physical functioning is maintained by compensating for the underlying disease.³⁰ Compensation, along with other factors such as optimization or selection, may affect people differently. People make adjustments and modifications during certain activities in an effort to maintain control over their involvement in these activities and avoid experiencing pain.²⁵ At equivalent stages of pain severity, some individuals may engage more in the compensation aspects of AMB than others do. This large variability may also have been influenced by including people with a wide range of pain severity and possibly diverse pain patterns. We expect that the extent to which AMB mediates PF and KR-QOL may change at different stages of the chronic knee pain experience.

Our study has several limitations. First, we made an explicit assumption that changes in pain severity precede engagement in AMB, which precedes changes in PF and KR-QOL. While this assumption is plausible, the cross-sectional study design does not allow us to establish causality. Future studies should test these hypotheses with a longitudinal design to establish temporal precedence and causality. Second, it is also likely that different subgroups of the sample engaged in AMB to varying degrees. Third, other factors may play a role in relationships between pain severity and KR-QOL and PF. For

example, use of pain medication may lessen the extent to which knee-pain severity leads to deterioration of KR-QOL and PF; alternatively, how people monitor their knee pain (e.g., their pain cycle) and interpret their knee-pain symptoms (e.g., whether pain is triggered mechanically by certain activities or spontaneously) may also mediate those associations.⁵ Fourth, the underlying pathophysiology causing knee pain was not determined; it may have been unrelated to OA, and therefore reflective of a general knee-pain syndrome. Finally, the response rate was 60%; to the extent that non-respondents differed from respondents, this sample may not be truly representative of middle-aged adults with emerging chronic knee pain, but may instead represent those with symptoms who are more concerned about their knee problems.

CONCLUSION

Activity-modifying behaviour partially mediated the effect of knee-pain severity on physical function and on knee-related quality of life. Behaviour is amenable to change, and cognitive and biopsychosocial factors have been found to predict disability in arthritic populations. Therefore, if AMB mediates the relationships between pain severity and PF and between pain severity and KR-QOL, it would be important for clinicians and researchers to explore ways in which AMB can enhance treatment of chronic knee pain.

KEY MESSAGES

What is already known on this topic

Pain causes disability and reduced quality of life in people with knee-pain problems such as knee osteoarthritis. It has not been demonstrated whether, among people with emergent chronic knee-pain problems, activity-modifying behaviour acts as a mediator for the relationship between the severity of knee pain and either physical function or knee-related quality of life.

What this study adds

The term *activity-modifying behaviour* describes the alternative strategies a person chooses to complete a physical task in the presence of challenges such as activity limitations and pain. Activity-modifying behaviour mediates the effect of pain severity on self-reported physical function and knee-related quality of life, and may therefore be an important target for preventing long-term loss of physical function and knee-related quality of life in adults with emergent chronic knee-pain problems.

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