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Relationships between illness representations, physical activity and depression in chronic kidney disease

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1 **Relationships between illness representations, physical activity and**
2 **depression in Chronic Kidney Disease**

3

4 **¹Nah Ryan, ¹Robertson Noelle, ²Niyi-Odumosu Faatihah A, ³Clarke Amy L,**
5 **²Bishop Nicolette C, ³Smith Alice C**

6

7

8 ¹Department of Neuroscience, Psychology and Behaviour, University of Leicester,
9 United Kingdom;

10

11 ²School of Sports Exercise and Health Sciences, Loughborough University, UK

12

13 ³Leicester Kidney Lifestyle Team, John Walls Renal Unit, University Hospitals of
14 Leicester NHS Trust and Department of Health Sciences, University of Leicester,
15 UK

16

17

18 Corresponding author:

19 Professor Alice C Smith

20 Leicester Kidney Lifestyle Team

21 Academic Unit

22 Leicester General Hospital

23 Leicester LE5 4PW

24 UK

25 Tel +44 116 258 4346

26 Email aa50@le.ac.uk

27

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29

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37

38 **Conflict of Interest Statement**

39 None of the authors of this manuscript have any conflicts of interest to
40 declare. The results presented in this paper have not been published
41 previously in whole or part, except in abstract format.

42

43 **Corresponding Author Biodata**

44 Alice Smith is Professor of Lifestyle Medicine at the University of Leicester
45 and the University Hospitals of Leicester NHS Trust. Her primary research
46 interest is the role of physical activity, exercise and lifestyle management in
47 kidney disease. Her translational research programme encompasses
48 laboratory-based exploratory and mechanistic work, and includes outcome
49 measure evaluation, lifestyle intervention development and effectiveness
50 testing, implementation and service evaluation. A strong track record of
51 patient involvement and engagement, and qualitative exploration of patient
52 perspectives and experience underpins all the work.

53

54 **Abstract**

55 Background: Chronic Kidney Disease (CKD) is exacerbated by depression
56 and confers significant healthcare costs. Whilst adverse impacts may be
57 mitigated by physical activity, many patients with CKD remain physically
58 inactive, with this physical inactivity potentially influenced by how CKD is
59 appraised.

60 Objectives: The study aims to explore the relationship between physical
61 activity, depression and illness representations in CKD.

62 Methods: Non-dialysing patients with CKD completed the Revised Illness
63 Perception Questionnaire (IPQ-R), Beck Depression Inventory (BDI-II) and
64 Short-Form International Physical Activity Questionnaire (IPAQ-SF) while
65 demographic information was obtained via medical records. Correlation and
66 regression analyses were conducted to determine the relationship of illness
67 representations with levels of physical activity. Moderation and mediation
68 analyses were performed to investigate the role of depression in any
69 relationship between illness representations and physical activity levels.

70 Results: Seventy respondents, with a mean age of 60 ± 16 years, the
71 majority being male (60%), took part in the study. Of illness representation
72 dimensions, personal control was positively associated with levels of
73 physical activity ($r=.288$, $p<.05$) while timeline cyclical was a significant
74 predictor ($Beta=-.423$, $p=.008$). Severity of depression was neither a
75 moderator ($b= .023$, 95% CI $[-.015, .061]$, $t=1.201$, $p=.23$) nor a mediator
76 ($b=-.021$, BCa CI $[-.082, .008]$, $p=.33$).

77 Conclusions: Facets of illness representations had significant relationships
78 with levels of physical activity. Future research concerning the development
79 and validation of psychological interventions based on an illness
80 representations framework for patients with CKD not on renal-replacement
81 therapy is proposed. The efficacy of such interventions could be then
82 evaluated using a randomised controlled method.

83 **Introduction**

84

85 Chronic Kidney Disease (CKD) is an irreversible long-term condition often
86 undiagnosed until an advanced stage where costs can be significant for the
87 individual and society (NICE 2015a). Adverse impacts of CKD appear
88 exacerbated by co-morbid mental health problems (Tonelli *et al.* 2015).
89 Depression is prevalent in individuals with CKD (EMPO 2010; NICE 2015b),
90 where 20 to 30 per cent of patients meet diagnostic criteria (Cukor *et al.*
91 2007) compared to point prevalence of 2 to 4 per cent in the general
92 community and 5 to 10 per cent in primary care settings (Hedayati *et al.*
93 2009). As CKD and depression have negative repercussions (Cruz *et al.*
94 2010, Farrokhi *et al.* 2014, Teles *et al.* 2014), and depression is a significant
95 co-morbidity magnifying adverse impact, increased attention has been
96 drawn to possible interventions that might mitigate the impact of both CKD
97 and depression.

98

99 Studies have found that engagement in physical activity and exercise
100 accrues significant physiological benefits such as improved cardiovascular
101 reactivity, eGFR and physical functioning and a reduction of inflammation
102 for individuals with CKD (Kosmadakis *et al* 2012, Smith & Burton 2012,
103 Gould *et al* 2014, Wilkinson *et al* 2018). A Cochrane review reported
104 evidence demonstrating beneficial effects of physical activity on CKD and
105 mood (Heiwe & Jacobson 2011).

106

107 Although activity and exercise have scope to mitigate the impact of CKD
108 and alleviate depression in patients with CKD, many individuals do not
109 undertake sufficient physical activity (Zamojska *et al.* 2006; Beddhu *et al.*
110 2009; Avesani *et al.* 2012; Hayhurst & Ahmed 2015). Explanatory theories
111 were developed to understand such phenomena and inform health
112 behavioural change interventions (Nigg *et al.* 2002). Notable amongst these
113 self-regulation models is Leventhal and Cleary's Common Sense Model
114 (CSM) of illness representations (Leventhal & Cleary 1980). The CSM
115 hypothesises that individuals with illnesses construct illness beliefs about
116 their health conditions, which influence health-related behaviours such as
117 the undertaking of physical activity.

118

119 Extensive research investigating how illness representations influence
120 health behaviours in chronic illnesses, notably rheumatoid arthritis, chronic
121 obstructive pulmonary disease (COPD) and multiple sclerosis (Hale *et al.*
122 2007) has been conducted. However, there is a paucity of research
123 exploring the relationship between illness representations and health
124 behaviour in CKD. No known studies have examined the roles of illness
125 representations in influencing the undertaking of physical activity for
126 patients with CKD particularly those not receiving renal replacement therapy
127 (also termed as patients with CKD-ND in this paper). Furthermore, illness
128 representations were found to differ between dialysing and non-dialysing
129 patients (Jansen *et al.* 2010; Jansen *et al.* 2013).

130

131 Hence, the current study aimed to determine if facets of illness
132 representations are associated and predictive of levels of physical activity
133 in patients with CKD-ND. This is of clinical importance as illness
134 representations were found to be modifiable (Hale *et al.* 2007), potentially
135 increasing physical activity, which mitigates the impact of CKD and
136 depression. Besides that, depression was found to be associated with
137 physical activity (Jekau & Brand 2017) and illness representations (Muscat
138 *et al.* 2018). Thus, the secondary study aim was to investigate if the severity
139 of depression has a moderating or mediating effect between illness
140 representations and levels of physical activity.

141

142 **Materials and Methods**

143

144 *Design, setting and participants*

145 Participants were recruited through convenience sampling in a UK renal
146 outpatient clinic from August 2016 to January 2017. A face-to-face
147 approach was adopted whereby patients were approached randomly and
148 introduced to the study. Eligible patients met the following inclusion criteria:
149 (i) diagnosis of CKD and not on dialysis, (ii) male or female aged 18 years
150 or above, (iii) were willing and able to give informed consent for study
151 participation, and (iv) were able to complete the measures in English.
152 Participants were given a study survey booklet to be taken away,
153 completed, and returned within 10 days. Medical records were accessed
154 after completed surveys were returned to extract relevant clinical details. All
155 participants in the study provided informed consent. The study was
156 sponsored by the University Hospitals of Leicester NHS Trust and approved
157 by the London Queen Square Research Ethics Committee (ref
158 16/LO/0980).

159

160 *Measures*

161 The International Physical Activity Questionnaire Short Form (IPAQ-SF), a
162 seven-item self-report questionnaire was used to assess participants' levels
163 of physical activity, which are categorised into four intensity levels: vigorous-
164 intensity activity; moderate-intensity activity; walking and; sitting (Craig *et*
165 *al.* 2003). The IPAQ-SF can be calculated as a continuous score by
166 multiplying activities' metabolic equivalent (MET) with the time spent

167 (minutes) and the number of days engaged in those activities. Individuals
168 can also be categorised into three levels of physical activity based on their
169 categorical score, specifically, 'Inactive', 'Minimally Active' and 'Health
170 Enhancing Physical Activity (HEPA) active' (IPAQ 2004).

171

172 The Beck Depression Inventory (BDI)-II, a 21-item self-report questionnaire
173 was used to assess participants' severity of cognitive and somatic
174 depressive symptoms in the past two weeks (Beck *et al.* 1988). Each item
175 is rated on a four-point Likert scale ranging from 0 to 3, with higher overall
176 scores reflecting greater severity of depression (Whisman & Richardson
177 2015). The BDI-II total score is further categorised into the following
178 depression severity categories: 'Minimal Depression' (0-13), 'Mild
179 Depression' (14-19), 'Moderate Depression' (20-28) and 'Severe
180 Depression' (29-63) (Beck *et al.* 1996). The BDI-II clinical cut off score of $\geq$
181 11 was established as having the best diagnostic accuracy for depressive
182 disorder in patients with CKD-ND (Hedayati *et al.* 2012).

183

184 Facets of illness representations were assessed by the Illness Perceptions
185 Questionnaire-Revised (IPQ-R). The IPQ-R is an 84-item self-report
186 questionnaire that measures the five components of CSM (Moss-Morris *et al.*
187 2002). The current study utilised the second section of the IPQ-R, which
188 consists of seven subscales: consequences, timeline acute/chronic and
189 cyclical, personal and treatment control/cure, illness coherence, and
190 emotional representations (Hill 2010). Each item is rated on a five-point
191 Likert-style scale (Hill 2010). Higher subscale scores reflect greater

192 endorsement of the given construct (Zoeckler *et al.* 2014). High scores on
193 consequences, timeline acute/chronic, cyclical and emotional
194 representation subscales represent negative illness beliefs that an illness
195 has adverse impacts, is chronic, cyclical in nature and generates a negative
196 emotional response respectively. Whereas high scores on illness
197 coherence and personal and treatment control indicate positive illness
198 beliefs where individuals understood their condition, felt in control over their
199 condition and the treatment received controls/cures the illness.

200

201 *Statistical methods*

202 Data analyses were performed using IBM SPSS statistics for Windows,
203 version 24 (Armonk, NY: IBM Corp). Descriptive statistics were employed
204 for participant characteristics. Continuous variables were described using
205 mean and standard deviation while dichotomous variables were described
206 using percentages. To ensure methodological robustness, non-normal data
207 were transformed first to correct for distributional problems and to achieve
208 normality. Subsequently, all analyses when applicable were bootstrapped
209 using 1000 samples and computed based on a bias-corrected and
210 accelerated (BCa) confidence interval.

211

212 Pearson correlations were used to investigate the associations between
213 facets of illness representations and levels of physical activity. Hierarchical
214 multiple regression analyses were used to model the relationships between
215 facets of illness representations, levels of physical activity, and participant
216 characteristics. As the study sample size is underpowered, Adjusted R

217 square values are reported (Pallant 2007). A post-hoc regression analysis
218 was conducted with only the predictors that made a statistically significant
219 contribution to the main regression analysis to address the small sample
220 size issue. Mediation and moderation analyses were performed using
221 Hayes' PROCESS macro for SPSS (Hayes 2012) to investigate the role of
222 depression in the hypothesised relationship between dimensions of illness
223 representations and level of physical activities.

224

225 For missing data, cases were excluded from the calculation of overall BDI
226 score if there were more than one missing datum. On the IPQ-R, cases
227 were excluded if more than two items are missing per subscale with the
228 exception of subscales with less than six items where a maximum of one
229 missing item is allowed. Expectation maximisation was used to manage the
230 missing data for IPAQ-SF for correlation and regression analyses. Little's
231 Missing Completely at Random (MCAR) test was run to ensure that missing
232 data for IPAQ-SF were completely random (Little 1988). 'Treatment Control'
233 subscale was excluded from regression analyses as the sample consisted
234 of non-dialysing participants with conservative treatment. The subscale was
235 considered lacking salience in predicting levels of physical activity, and
236 simple correlation examined between treatment control and levels of
237 physical activity yielded no significant association. All statistical analyses
238 adopted a pairwise exclusion method.

239

240 **Results**

241

242 *Patient characteristics*

243 164 patients were approached, of these, 64 declined to take part in the
244 study. 100 patients consented to participate, but 30 did not return the survey
245 booklet and were withdrawn from the study. The final sample comprised 70
246 patients with CKD-ND (43% participation rate). The majority of these were
247 male (60%), identified as 'White British' (80%), with a mean age of 60 ± 16
248 years. Demographics and clinical data are reported in Table 1.

249

250 [Table 1]

251

252 *Levels of physical activity*

253 Approximately a third of the participants (35%) were sedentary, meeting the
254 criteria of low/inactive level of physical activity, and thus considered
255 insufficiently active. Whereas 39% individuals met the criteria of 'Minimally
256 Active', achieving the recommended minimum level of activity for adults, but
257 insufficient when considering total level of physical activity. Only 26% of the
258 sample met the HEPA active category, which describes individuals as
259 exceeding the minimum public health physical activity guidelines and
260 leading a healthy lifestyle. The sample's median level of physical activity
261 expended per week is 1386 MET-min, which meets the category 'Minimally
262 Active'.

263 *Depression severity*

264 Participants generally reported 'Minimal Depression' with 63.2% of
265 participants' scores in this category, 17.6% for 'Mild Depression, 11.8% for
266 'Moderate Depression' and 7.4% for 'Severe Depression' (Table 2). The
267 mean BDI-II score for the sample was 12.0 ± 9.6 with a range of 0-45. Half
268 (50%) of the participants had a BDI-II cut-off score of ≥ 11 .

269

270 [Table 2]

271

272 *Association of illness representations with levels of physical activity*

273 There was a small positive correlation between personal control and level
274 of physical activity ($r=.288$, $p=.034$), suggesting that individuals who
275 perceived themselves as having more personal control were more likely to
276 engage in higher levels of physical activity. Correlations between timeline
277 cyclical and levels of physical activity approached statistical significance ($r=-$
278 $.242$, $p=.078$). No other components of illness representations were
279 significantly associated with levels of physical activity. Findings are
280 presented in Table 3.

281

282 [Table 3]

283

284 *Primary regression analysis*

285 The change in Adjusted R Square scores ($\Delta R^2_{\text{Adjusted}}=.142$, $p=.027$)
286 indicated that illness representation components accounted for 14.2% of the
287 variance in IPAQ-SF scores after effects of age and eGFR were removed

(Table 4). Of illness representation components, only timeline cyclical (Beta=-.423, $p=.008$) made a statistically significant contribution to the variance reported. Overall, Model 2 is significantly better at predicting the outcome with improvement greater than the inaccuracy within the model ($F(8, 47)= 3.23, p=.005$). The variables in Model 2, including age and eGFR, contributed to 24.5% of the variance in IPAQ-SF scores ($R^2_{\text{Adjusted}}=.245, p=.027$). Other than time cyclical, age is the only other predictor that made a significant unique contribution in Model 2 (Beta=-.353, $p=0.41$). Timeline cyclical made the largest unique contribution between the two predictors.

297

298 [Table 4]

299

300 *Post-hoc regression analysis*

301 A post-hoc hierarchical multiple regression analysis (Table 5) was
302 conducted with the significant predictors from the main analysis, age and
303 timeline cyclical, as variables. Timeline cyclical accounted for 8.1% of the
304 variance in IPAQ-SF scores after controlling for age ($\Delta R^2_{\text{Adjusted}}=.081, p=.009$) while Model 2 as a whole explains 21.1% of the variance
305 ($R^2_{\text{Adjusted}}=.211, p=.009$). Both timeline cyclical (Beta = -.312, $p=.005$) and
306 age (Beta=-.451, $p=.011$) made a statistically significant contribution to the
307 variance reported. Overall, Model 2 significantly improved the predictability
308 of IPAQ-SF scores compared to not fitting the model ($F(2, 61)= 9.44, p<.001$).

311

312 [Table 5]

313

314 *Moderation and mediation analyses*

315 Moderation analysis was conducted with levels of physical activity (IPAQ-
316 SF) as the dependent variable, timeline cyclical as the independent variable
317 and severity of depression (BDI-II) as the moderator variable (Table 6).
318 Findings suggest that the relationship between timeline cyclical and levels
319 of physical activity is not moderated by severity of depression as the
320 interaction effect is not significant ($b = .023$, 95% CI $[-.015, .061]$, $t = 1.201$,
321 $p = .23$).

322

323 [Table 6]

324

325 Similarly, mediation analysis (Figure 1) was conducted with levels of
326 physical activity (IPAQ-SF) as the dependent variable, timeline cyclical as
327 the independent variable and severity of depression (BDI-II) as the mediator
328 variable. Results indicated that severity of depression was not a mediator
329 as there is no significant indirect effect of timeline cyclical on levels of
330 physical activity through severity of depression ($b = -.021$, BCa CI $[-.082,$
331 $.008]$, $p = .33$).

332

333 [Figure 1]

334

335 **Discussion**

336

337 The present study is the first to examine the relationship between illness
338 representations and levels of physical activity in patients with CKD-ND.
339 Findings of this study suggest that illness representation elements are
340 associated with, and predictive of, levels of physical activity in accordance
341 with the CSM model assumptions, in which perceptions of a condition such
342 as CKD influence coping and the utilisation of health behaviours (Leventhal
343 *et al.* 1984). Regarding the secondary aim, depression was not found to
344 mediate or moderate the predictive relationship between timeline cyclical
345 and levels of physical activity.

346

347 Almost three-quarter of the sample (74%) undertook insufficient levels of
348 physical activity. This is expected as CKD has been found to be associated
349 with impaired physical activity (Beddhu *et al.* 2009). Half of the sample had
350 a BDI-II cut-off score of ≥ 11 , which is indicative of a depressive
351 presentation. This rate is more than twice reported in a systematic review
352 on the prevalence of depression in CKD (Palmer *et al.* 2013). The reason
353 for this discrepancy is unclear. Our study sample comprised only patients
354 with CKD-ND, thus excluding those receiving renal replacement therapy or
355 had kidney transplants.

356

357 Regarding associative relationship, only personal control had a statistically
358 significant positive correlation with levels of physical activity, suggesting that
359 patients with CKD-ND who perceived themselves as having more control

360 over their illness were more likely to engage and undertake higher levels of
361 physical activity. This is consistent with Hagger and Orbell (2003) meta-
362 analysis examining the relationship between illness representations and
363 health behaviours and illness outcomes. They found that CSM cure/control
364 dimension, equivalent to personal control, was positively correlated with
365 specific problem-focused coping strategies such as exercise (Hagger &
366 Orbell 2003). Perception of personal control over illness was related to
367 active coping strategies, which was reflected in our results. In the context of
368 CKD, where the main goal of physical activity is to improve disease
369 management as opposed to cure, it could define an important coping
370 strategy. Similarly, the French *et al.* (2006) systematic review with meta-
371 analysis reported patients with cardiovascular disease (CVD) disclosing
372 greater CSM cure/control appraisals were more likely to attend cardiac
373 rehabilitation, indicating active coping through the engagement of health
374 behaviour. The positive association between personal control and levels of
375 physical activity has also been established in CVD research studies (Reges
376 *et al.* 2013; Mosleh & Almalik 2016).

377

378 Timeline cyclical dimension predicted levels of physical activity and
379 remained statistically significant for the post-hoc regression analysis.
380 Patients with CKD-ND who considered their illness and symptoms as
381 unpredictable and cyclical undertook lower levels of physical activity. This
382 finding parallels Sniehotta *et al.* (2010) who similarly concluded that timeline
383 cyclical predicted levels of physical activity in patients with CVD. It is
384 possible that patients with CKD-ND who perceived their condition as cyclical

385 may adopt an avoidant coping style by not employing health behaviours for
386 the fear of aggravating their symptoms (Sniehotta *et al.* 2010). Such
387 explanation is congruent with Hagger and Orbell (2003) who found that the
388 timeline dimension, which consists of both acute/chronic and cyclical
389 components, were positively associated with avoidance and denial.

390

391 The predictive relationship between timeline cyclical and levels of physical
392 activity were neither moderated nor mediated by the severity of depression.
393 This is expected as severity of depression was not significantly associated
394 with levels of physical activity. One possible explanation for the lack of
395 significance was that missing data in the IPAQ-SF, substituted by
396 suggested values through expectation maximisation technique, could have
397 influenced the statistical significance. This appears confirmed by a post-hoc
398 simple correlation analysis using the original IPAQ-SF data with no data
399 imputation where results indicated a significant negative relationship
400 between severity of depression and levels of physical activity.

401

402 *Limitations*

403 There are several limitations in the current study. Whilst our findings have
404 shown a relationship between illness representations and physical activity,
405 only two of the seven domains of the CSM were statistically significant,
406 indicating a limitation of the CSM as an explanatory model for physical
407 activity behaviour. Results emerged from a within group cross-sectional
408 survey design, which precluded causal examination and comparisons
409 across groups. Additionally, the self-report measures (IPAQ-SF and BDI-II)

410 are prone to recall bias, which threatens the validity of the data (Raphael
411 1987). We acknowledge the small sample size and made stringent attempts
412 to address power: a post-hoc regression analysis with two predictor
413 variables was conducted, which met the 15 cases per predictor variable
414 requirement for social sciences research (Stevens 1996). Future studies
415 could address the power issue by recruiting a larger sample and refining
416 data collection method, such as using online survey systems. With
417 participant characteristics of the sample indicating more males than the
418 prevalence model (Roth *et al.* 2010), and the sample reporting more
419 depression compared to other studies (Palmer *et al.* 2013), results are not
420 entirely generalisable to the CKD population, and are restricted to patients
421 with CKD-ND. Our study population also had a higher percentage of White
422 British participants (80%) than the local CKD population (70%). These
423 differences possibly could be due to the sampling method adopted, which
424 results in selection bias (Acharya *et al.* 2013). Moreover, individuals who
425 declined to take part in the study may differ from those who volunteered for
426 the study, resulting in non-response bias (Sedgwick 2014).

427

428 *Implications for clinical practice*

429 Our study results suggest a predictive relationship between timeline cyclical
430 and levels of physical activity, which are neither moderated nor mediated
431 by the severity of depression. This demonstrates that timeline cyclical is an
432 important predictor and on its own has a direct effect on levels of physical
433 activity. This is a key finding, with important clinical implications given the
434 substantial evidence that patients with CKD undertake insufficient physical

435 activity (Zamojska *et al.* 2006; Beddhu *et al.* 2009; Avesani *et al.* 2012;
436 Hayhurst & Ahmed 2015), with potential adverse consequences (Beddhu *et*
437 *al.* 2009; Zelle *et al.* 2017). Furthermore, research has found that exercise
438 is beneficial for patients with CKD (Heiwe 2011) and associated with better
439 outcomes (Tentori *et al.* 2010), including non-dialysing patients (Gould *et*
440 *al.* 2014).

441

442 Given that components of illness representations appeared to underpin and
443 direct the motivation to engage in physical activity, better understanding and
444 targeting of patient appraisals in this population appears warranted. Clinical
445 resources could be invested for nurses to conduct routine psychological
446 assessment and screening for patients with CKD-ND, to assess their illness
447 representations. Development of psychological interventions specifically to
448 address unhelpful representations could also be considered and delivered
449 by trained nursing staff (Hale *et al.* 2007, Hudson *et al.* 2016). For instance,
450 psychoeducation on CKD could be provided to increase patients'
451 understanding and knowledge of the condition, which could potentially
452 empower them and increase personal control. With enhanced knowledge,
453 individuals could identify early warning signs of their symptoms, and work
454 with health providers to better manage their condition to enhance stability
455 and prevent deterioration. Enhanced awareness and active illness
456 management could mitigate perceptions of illness unpredictability and
457 improve perceived controllability. Research has established the efficacy of
458 illness representations-based interventions in increasing physical activity in
459 patients after myocardial infarction (Broadbent *et al.* 2009), and improving

460 clinical and psychological outcomes in diabetic patients (Keogh *et al.* 2011).
461 Similarly, such focused interventions should be timely provided for patients
462 with CKD-ND to enhance and sustain uptake of physical activity and
463 potentially mitigate the effects of depression.
464

465 **Conclusion**

466 The current study has established the relationship of illness representations
467 with levels of physical activity. Future research concerning the development
468 and validation of psychological interventions specific to the modification of
469 illness representations in patients with CKD-ND is encouraged. In addition,
470 robust design adopting randomised controlled method could examine
471 efficacy of such treatments and establish causal links between illness
472 representations and levels of physical activity.

473

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694 **Tables**

695

696 **Table 1: Sample characteristics**

697

Study sample (n=70)	
Age	
Mean age (SD)	60.1 (15.9)
Median age (in years)	60
Age range (%)	
18-39 years	8 (11.4%)
40-59 years	26 (37.1%)
60 years and above	36 (51.4%)
Gender (%)	
Male	42 (60%)
Female	28 (40%)
Ethnicity (n=67)	
White British	56
Indian	7
White any other background	1
White and Black Carribean	1
White Asian	1
Pakistani	1
Level of Education (n=68) (%)	
Lower Secondary Qualification	17 (25%)
Upper Secondary Qualification	6 (8.8%)
University or College below a degree	16 (23.5%)
University or College degree	15 (22.1%)
None of these	14 (20.6%)
Smoking Status (%)	
Never smoked	37 (52.9%)
Current smoker	5 (7.1%)
Ex-smoker	28 (40%)
Comorbidity Reported (n=66) (%)	
Yes	50 (75.8%)
No	16 (24.2%)
Stage of CKD (%)	
Stage 1	2 (2.9%)

Stage 2	16 (22.9%)
Stage 3	14 (20%)
Stage 4	32 (45.7%)
Stage 5	6 (8.6)
Onset of CKD (n=69)	
Onset of CKD range (in months)	0.5 - 360
Mean onset of CKD in months (SD)	110.6 (100.6)
eGFR (n=68) (ml/min/1.73m²)	
eGFR range	8 - 90
Mean eGFR (SD)	34.5 (22.3)

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700 **Table 2: BDI-II results summary**

Study sample (n=68)	
<i>Depression severity category (%)</i>	
Minimal Depression	43 (63.2%)
Mild Depression	12 (17.6%)
Moderate Depression	8 (11.8%)
Severe Depression	5 (7.4%)
<i>BDI score</i>	
Mean BDI score (SD)	12.0 (9.6)
<i>BDI cut-off score criteria (%)</i>	
BDI score $\geq$ 11	34 (50%)

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Table 3: Correlations for participant characteristics, levels of physical activity, illness representations and severity of depression

	Participant Characteristics				IPQ-R				IPAQ-SF		BDI-II
	1	2	3	4	5	6	7	8	9	10	11
1. Age	-	-.277*	-.042	-.310*	-.096	-.132	-.134	.013	-.368**	-.291*	-.168
2. eGFR		-	.095	-.073	-.425**	.125	-.134	.087	-.035	.227	-.010
3. Timeline (Acute/Chronic)			-	.041	-.136	.113	.489**	-.268	-.067	.071	-.154
4. Timeline Cyclical				-	.403**	-.073	.178	-.245	.470**	-.242	.582**
5. Consequences					-	-.197	-.016	-.165	.430**	-.109	.463**
6. Personal Control						-	.475**	.435**	-.366**	.288*	-.354**
7. Treatment Control							-	.079	-.153	.125	-.071
8. Illness Coherence								-	-.544**	-.042	-.277*
9. Emotional Representations									-	-.003	.654**
10. IPAQ-SF										-	-.245
11. Overall BDI-II Score											-

Note: * $p < 0.05$; ** $p < 0.01$ (2-tailed).

Table 4: Multiple regression analysis for levels of physical activity (IPAQ-SF), with 95% BCa confidence intervals reported in parentheses. Confidence intervals and standard errors based on 1000 bootstrap samples

Variable	Model 1				Model 2			
	<i>b</i>	<i>SE B</i>	β	<i>p</i> (2-tailed)	<i>B</i>	<i>SE B</i>	β	<i>p</i> (2-tailed)
Age	-.016 (-.035, -.001)	.009	-.277	.081	-.021 (-.039, -.004)	.009	-.353	.041
eGFR	.541 (-.194, 1.323)	.360	.171	.138	.450 (-.399, 1.264)	.448	.143	.358
Timeline Acute/Chronic					-.052 (-.246, .137)	.114	-.057	.656
Timeline Cyclical					-.106 (-.181, -.029)	.036	-.423	.008
Consequences					.016 (-.044, .078)	.031	.101	.612
Personal Control					.067 (.005, .137)	.036	.343	.093
Illness Coherence					-.057 (-.118, .009)	.033	-.307	.106
Emotional Representations					-.002 (-.068, .060)	.035	-.011	.968

Note: $R^2=.136$ and $R^2_{\text{Adjusted}}=.103$ for Model 1; $\Delta R^2=.219$ and $\Delta R^2_{\text{Adjusted}}=.142$ for Model 2 ($p<.05$).

Table 5: Post-hoc regression analysis for levels of physical activity (IPAQ-SF), with 95% BCa confidence intervals reported in parentheses. Confidence intervals and standard errors based on 1000 bootstrap samples

	<i>b</i>	<i>SE B</i>	β	<i>p</i> (2-tailed)
Model 1				
<i>Age</i>	-.023 (-.039, -.009)	.008	-.380	.017
Model 2				
<i>Age</i>	-.028 (-.046, -.012)	.008	-.451	.011
<i>Timeline Cyclical</i>	-.085 (-.139, -.031)	.027	-.312	.005

Note: $R^2=.144$ and $R^2_{\text{Adjusted}}=.130$ for Model 1; $\Delta R^2=.092$ and $\Delta R^2_{\text{Adjusted}}=.081$ for Model 2 ($ps<.01$).

Table 6: Moderation analysis for levels of physical activity (IPAQ-SF)

	<i>b</i>	<i>SE B</i>	<i>t</i>	<i>p</i>
<i>BDI-II</i>	-.095 (-.260, .070)	.0825	-1.153	.254
<i>Timeline Cyclical</i>	-.029 (-.093, .036)	.032	-.888	.378
<i>BDI-II x Timeline Cyclical</i>	.023 (-.015, .061)	.0191	1.201	.23

Note: $R^2=.078$ ($p=0.56$).

Figure

Figure 1. Mediation analysis for levels of physical activity (IPAQ-SF). Severity of depression did not act as a mediator as the indirect effect was statistically insignificant.