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Original article

Perceptions of sitting posture among members of the community, both with and without non-specific chronic low back pain

Kieran O'Sullivan [a,*], Mary O'Keeffe [a], Leonard O'Sullivan [a], Peter O'Sullivan [b], Wim Dankaerts [c]

[a] University of Limerick, Limerick, Ireland
[b] Curtin University, Perth, WA, Australia
[c] Catholic University, Leuven, Belgium

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ABSTRACT

Physiotherapists perceive upright, lordotic sitting postures to be important in the management of non-specific chronic low back pain (NSCLBP). Little is known about the perceptions of the wider community about seated posture, despite this being an important consideration before attempting to change seated posture. This study investigated perceptions of the best and worst sitting postures among members of the community, both with ($n = 120$) and without ($n = 235$) NSCLBP. Participants with NSCLBP perceived posture to be more important ($p < 0.001$), and reported thinking about their posture significantly more frequently ($p < 0.001$), than those without NSCLBP. 54% of participants selected a "neutral" lordotic sitting posture as their best posture, which was more frequent than any other posture ($p < 0.001$). Sitting postures which were "straight", and were perceived to keep the head, neck and shoulders in good alignment were preferred. However, what people considered "straight" varied considerably. 78% selected a slumped sitting posture as their worst posture, which was more frequent than any other posture ($p < 0.001$). The choice of best and worst sitting postures was not significantly influenced by gender, the presence of NSCLBP, or measures of pain, disability or back pain beliefs. Interestingly, a very upright sitting posture was the second most popular selection as both the best (19%) and worst (15%) posture. Overall, lordotic lumbar postures were strongly favoured among members of the community, which is broadly in line with the previously reported perceptions of physiotherapists.

1. Introduction

Non-specific chronic low back pain (NSCLBP) is a complex musculoskeletal disorder, with numerous contributing factors across the biopsychosocial spectrum (Moseley, 2007; Campbell and Edwards, 2009). Increased sitting duration does not increase the risk of developing NSCLBP (Roffey et al., 2010). In addition, a systematic review reported no evidence of a close relationship between sagittal spinal curvature and NSCLBP (Christensen and Hartvigsen, 2008). However, the quality of the available literature included in that review was described as "very low". Therefore, due to the reported aggravation of NSCLBP in sitting (Dankaerts et al., 2006), and the increased sitting time in modern society, physiotherapists commonly advise on sitting posture in the management of NSCLBP (Poitras et al., 2005).

Recent research has highlighted inconsistencies on what constitutes an optimal seated lumbar posture (Claus et al., 2009b; O'Sullivan et al., 2010). While reduced lumbar lordosis occurs during sitting (Scannell and McGill, 2003; Dunk et al., 2009; De Carvalho et al., 2010), a large degree of lumbar flexion in sitting is often suggested to be unhelpful (Williams et al., 1991). Sitting posture also varies with gender (Smith et al., 2010). Furthermore, people with NSCLBP appear to present with provocative sitting postures, which can be near either end-range flexion (kyphotic) or extension (lordotic) (Dankaerts et al., 2006).

Physiotherapists strongly favoured lordotic sitting postures in a recent study (O'Sullivan et al., 2012). The most commonly selected posture involved a relatively "neutral" sitting posture with moderate lumbar lordosis and a relaxed thorax (O'Sullivan et al., 2012). The physiotherapists highlighted the trade-off between proposed advantages of upright sitting postures such as supporting spinal structures and maintaining the "natural shape of the spine", and the costs in terms of increased muscular effort and spinal loading (O'Sullivan et al., 2006; Claus et al., 2009a). Differences also existed

* Corresponding author. Department of Clinical Therapies, University of Limerick, Ireland. Tel.: +353 61 234119; fax: +353 61 234251.
E-mail address: kieran.osullivan@ul.ie (K. O'Sullivan).

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between the physiotherapists regarding the optimal degree of spinal extension in sitting.

No previous study has examined the perceptions of members of the community, either with or without NSCLBP, about sitting postures. This is notable considering perceptions about optimal sitting posture are likely to influence how people load their spine in daily seated tasks, consistent with existing models of health and illness behaviour (Leventhal et al., 2003) and evidence that other behaviours relevant to NSCLBP are consistent with beliefs about NSCLBP (Darlow et al., 2012). Before determining if, and how, spinal posture should be modified in people with NSCLBP, it is important to understand perceptions regarding spinal posture among members of the community. It was hypothesised that they would select lordotic sitting postures as optimal. However, it was unclear whether these would vary between those with and without NSCLBP, and between genders. Therefore, the primary aim of this study was to investigate the perceptions of members of the community on the best and worst sitting posture. A secondary aim was to examine whether these perceptions differed between people with and without NSCLBP.

2. Methods

2.1. Participants

355 (132M/223F) members of the community participated in this study, including 120 reporting NSCLBP (>three months duration) in the previous year and 235 control participants not reporting NSCLBP in the previous year.

2.2. Photographs of posture

Photographs of nine different sitting postures from a previous study (O'Sullivan et al., 2012) were used. Detail regarding the setup for these photographs has been published previously (O'Sullivan et al., 2012), such that only the main details are provided here. A 29 year-old female without NSCLBP was used as a model. While using both male and female models would be advantageous, attempting to re-create the exact same spinal angle in male and female models appeared to require very different degrees of effort on pilot testing. A digital camera (Panasonic Lumix TZ3) was positioned on a tripod 80 cm from the floor and 250 cm from the model, with the model facing perpendicular to the camera. Spinal markers placed overlying the spinous processes of C7, T12, L3 and S2 facilitated calculation of sagittal-plane angles for the thoracic (C7-T12-L3), lumbar (T12-L3-S2), and overall thoraco-lumbar (C7-T12-S2) regions using a LABVIEW programme. As such, these angles represent simple sagittal-plane spinal flexion, rather than forward tilt or lean of the trunk. The nine options included a range of postures observed in clinical practice between slumped and upright sitting, including some postures with varying cervical, thoracic and lumbar spine angles, as well as varying degrees of trunk lean. The postures were randomly numbered from one to nine, starting in the top left hand corner (Fig. 1). The model's face was obscured in each photograph. It was hypothesised that such a mix of postures would facilitate the participants having to prioritise their concepts of optimal sitting. For example, the most lordotic lumbar posture involved thoracic flexion along with relaxation of the neck and shoulders. The actual spinal angles associated with each posture are displayed in Table 1.

2.3. Data collection

Participants were recruited while attending for treatment at local pain medicine and physiotherapy clinics, while painfree control participants were recruited from within the local community through attending social and sporting events, and through word of mouth. After obtaining informed consent, participants viewed the nine photographs either electronically (colour format) or in paper format (A4 black and white). They were asked to view all nine postures, and then select both their perceived best and worst posture, justifying their selection with some comments on the relative advantages and disadvantages of the selected postures. The specific instruction was to "select the best posture for the spine as a whole, especially the lumbar spine". Participants were asked to

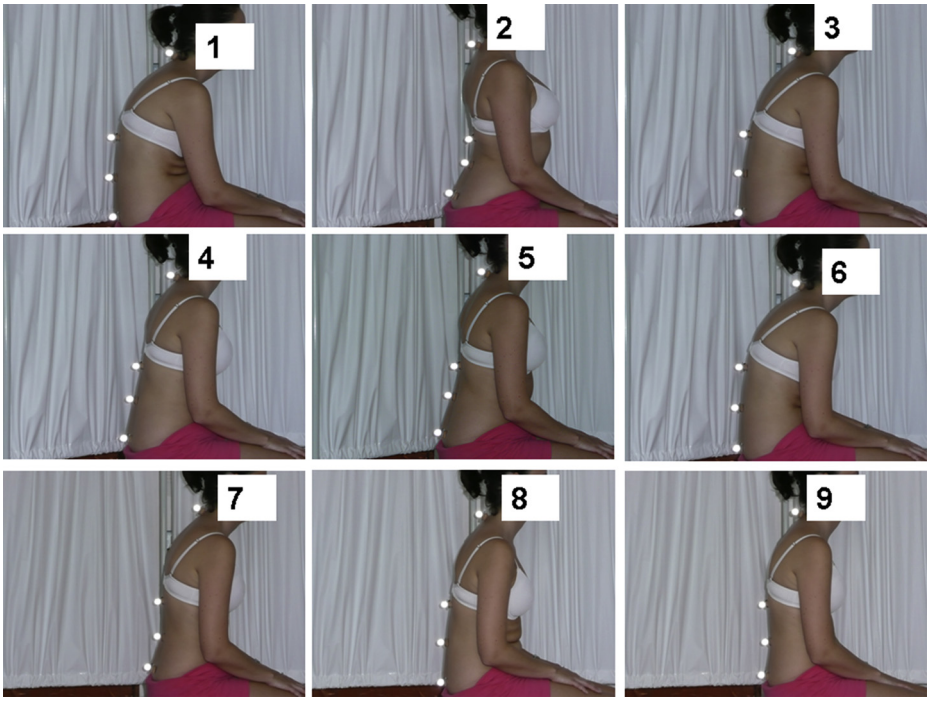

Fig. 1. The nine sitting posture options, numbered according to the descriptions in the main text.

Table 1
Spinal angles for each of the selected photographs.

Posture	Thoraco-lumbar (C7-T12-S2)	Thoracic (C7-T12-L3)	Lumbar (T12-L3-S2)
1	32.7	28.9	7.6
2	−16.5	−7.0	−16.3
3	24.8	21.4	6.9
4	10.4	9.5	1.7
5	2.1	4.0	−3.4
6	30.6	26.9	7.5
7	14.0	21.9	−16.6
8	18.3	15.5	5.4
9	18.8	23.7	−10.6

C7 – spinous process of 7th cervical vertebra; T12 – spinous process of 12th thoracic vertebra; L3 – spinous process of 3rd lumbar vertebra; S2 – positioned in midline between both posterior superior iliac spines; positive values indicate flexion; negative angles indicate extension; all values in degrees.

rate on a five point Likert scale both how important they thought spinal posture was in the management of NSCLBP (very important to unimportant), and how often they considered their own spinal posture (always to never). Participants were asked to tick all those body sites in which they experienced pain in the last 12 months, based on the body sites used in the Nordic Musculoskeletal Questionnaire. People with NSCLBP rated their pain severity using the average of the four (maximum, minimum, average, now) numeric rating scales (NRS) of the Brief Pain Inventory (Wand et al., 2011). They also completed the Oswestry Disability Index (ODI) (Fairbank and Pynsent, 2000), the physical activity subscale of the Fear-Avoidance Beliefs Questionnaire (FABQ) (Waddell et al., 1993) and the Back Beliefs Questionnaire (BBQ) (Buchbinder and Jolley, 2005). Participant characteristics are displayed in Table 2.

2.4. Data analysis

Data were analysed using SPSS 19.0. People with and without NSCLBP were initially compared for gender (chi-square – χ^2), as well as age and number of pain sites (Mann–Whitney *U* test). The frequency with which specific postures were selected as the best and worst postures was analysed using descriptive statistics. Chi-square (χ^2) was used to compare the perceived importance of posture, and how often participants thought about posture, between those with and without NSCLBP. Chi-square (χ^2) was also used to compare the frequency with which the two most commonly selected postures for both best posture (postures 9 and 2) and worst posture (postures 1 and 2) varied according to NSCLBP status, gender, frequency of thinking about their posture, perceived importance of posture (important versus very important), and number of pain sites (none versus at least one). Finally, chi-square (χ^2) compared the frequency with which the two most commonly selected best and worst postures were selected between those above/below the median value for age, and within the NSCLBP group only for pain, functional disability, fear-avoidance and back beliefs. All qualitative comments justifying selection of best and worst sitting posture were categorised into common sub-themes initially, and thereafter into major themes by one author (KOS), for both people with and without NSCLBP. The frequency with which these major positive and negative themes were used was also calculated for each posture. Another author (MOK) then analysed every comment to verify both the major themes, and the frequency of their appearance in the comments. Statistical significance was set at $p < 0.05$.

Table 2
Participant characteristics, for people with non-specific chronic low back pain (NSCLBP) and controls

	NSCLBP	Controls	*p* values
Age[#]	31(22–48)	29(22–41)	0.163
Gender (F/M)	72/48	151/84	0.433
Number of pain sites[#,*]	3(2–4)	0(0–1)	<0.001
NRS	3.9(2.3)	NA	NA
ODI	24.0(15.8)	NA	NA
BBQ	24.6(7.2)	NA	NA
FABQ[#]	14(10–18)	NA	NA

Data expressed as mean(SD), except where data non-normally distributed and expressed as median(interquartile range), as indicated by #; * – statistically significant; F – female; M – male; NRS – numeric rating scale; ODI – Oswestry Disability index; BBQ – back beliefs questionnaire; FABQ – physical activity subscale of the fear-avoidance beliefs questionnaire; NA – not applicable.

3. Results

3.1. Differences between people with and without NSCLBP

There was no significant difference in age ($p = 0.163$) or gender distribution ($p = 0.433$) between those with and without NSCLBP. However, people with NSCLBP had a significantly higher number of total pain sites ($p < 0.001$).

3.2. Participant thoughts on NSCLBP and posture

98% of people with NSCLBP, and 96% of controls, thought spinal posture was important or very important in the management of NSCLBP. Participants most commonly reported that they thought about their spinal posture "occasionally" (41%), followed by "very frequently" (23%) and "rarely" (22%). Those with NSCLBP thought about their spinal posture significantly more frequently (χ^2 (4,$n = 355$) = 40.397, $p < 0.001$), and were significantly more likely to consider posture as "very important" (χ^2 (1,$n = 337$) = 4.282, $p = 0.039$) than those without NSCLBP.

3.3. The best sitting posture

The percentage of people, both with and without NSCLBP, who selected each sitting posture option as the best sitting posture is displayed in Table 3. Posture 9 was most commonly selected as the best sitting posture, followed by posture 2 in both people with and without NSCLBP. Posture 9 involved a relatively neutral spine sitting posture with lordosis mainly in the lumbar spine and with relaxation of the thorax, while posture 2 involved a large degree of extension in both the lumbar and thoracic regions. Posture 9 was significantly more popular than posture 2; χ^2 (1,$n = 258$) = 61.54, $p < 0.001$. Furthermore, posture 2 in turn was significantly more popular than posture 5, which was the next most commonly selected best posture; χ^2 (1,$n = 104$) = 7.54, $p = 0.006$.

Table 3
Percentage of people, with and without non-specific chronic low back pain (NSCLBP), who selected each posture as the best and sitting posture.

Posture selected	Best		Worst	
	NSCLBP ($n = 120$)	Controls ($n = 235$)	NSCLBP ($n = 120$)	Controls ($n = 235$)
1	0	0	78.3	78.3
2	19.2	18.3	14.2	14.9
3	0.8	0	1.7	1.7
4	9.2	6.0	0	0
5	15.8	8.1	0	0
6	0	0.4	5.8	4.7
7	0.8	1.7	0	0.4
8	7.5	7.6	0	0
9	46.7	57.8	0	0
Total	`100.0	100.0	100.0	100.0

3.4. The worst sitting posture

The percentage of people, both with and without NSCLBP, who selected each sitting posture option as the worst sitting posture is displayed in Table 3. Posture 1 was most commonly selected as the worst sitting posture, followed by posture 2. Posture 1 involved slumped sitting, with posterior pelvic tilt and relaxation of the trunk muscles, while posture 2 involved extension throughout the lumbar and thoracic regions. Posture 1 was selected significantly more frequently as the worst posture than posture 2; χ^2 $(1,n = 330) = 154.78$, $p < 0.001$. Furthermore, posture 2 in turn was selected significantly more frequently than posture 6, the next most frequently selected as the worst posture; χ^2 $(1,n = 70) = 16.51$, $p < 0.001$.

3.5. Factors influencing selection of postures

Despite some variation regarding best sitting posture (Table 3), there was no significant difference between those with and without NSCLBP for either the best (χ^2 $(1,n = 258) = 0.746$, $p = 0.388$) or worst (χ^2 $(1,n = 330) = 0.025$, $p = 0.875$) sitting posture. While females selected posture 9 more frequently as the best posture, there were no significant differences between genders for either best (χ^2 $(1,n = 258) = 2.121$, $p = 0.145$) or worst (χ^2 $(1,n = 330) = 0.846$, $p = 0.358$) posture. On the basis that there were no differences in the choice of best and worst posture based on NSCLBP status, the relationships between posture selection and other factors were done without reference to NSCLBP status. How often participants thought about their posture was not significantly related to their choice of best (χ^2 $(1,n = 257) = 2.85$, $p = 0.584$) or worst (χ^2 $(1,n = 329) = 7.92$, $p = 0.095$) sitting posture. The perceived importance of posture was not significantly related to their choice of best (χ^2 $(1,n = 248) = 1.59$, $p = 0.207$) or worst (χ^2 $(1,n = 315) = 0.13$, $p = 0.910$) sitting posture. Similarly, the presence of pain at any site was not significantly related to their choice of best (χ^2 $(1,n = 256) = 0.032$, $p = 0.857$) or worst (χ^2 $(1,n = 315) = 0.013$, $p = 0.910$) sitting posture. Age was also not significantly related to their choice of best (χ^2 $(1,n = 253) = 1.114$, $p = 0.291$) or worst (χ^2 $(1,n = 324) = 0.123$, $p = 0.725$) sitting posture. Finally, among those participants with NSCLBP, the choice of best and worst sitting postures did not vary significantly according to their pain intensity, functional disability, back beliefs or fear-avoidance beliefs (all $p > 0.05$).

3.6. Qualitative comments on the postures selected

The major themes identified with the two most commonly selected postures for both best and worst sitting posture are summarised here. The comments of both people with and without NSCLBP have been discussed together since there were no quantitative differences in posture perceptions based on NSCLBP status, and the comments for both groups were considered by both assessors (KOS, MOK) to be similar. The main positive themes identified for posture 9 were the importance of being (i) straight or upright ($n = 144$), and maintaining the (ii) shoulders ($n = 44$), or (iii) head and neck ($n = 27$) in good alignment. Interestingly, the main positive themes identified for posture 2 were also being (i) straight or upright ($n = 36$), and maintaining good alignment of the (ii) shoulders ($n = 18$), as well as (iii) the head and neck ($n = 18$). Consistent with this, the main negative themes identified for posture 1 were (i) not being straight enough ($n = 250$), (ii) poor shoulder alignment ($n = 20$), (iii) poor head and neck alignment ($n = 26$), and (iv) perceived pressure or compression on the spine ($n = 31$). Interestingly, the main negative themes identified for posture 2 were quite different, such as being (i) too stiff or rigid ($n = 24$), (ii) too curved or upright ($n = 21$), (iii) uncomfortable ($n = 9$) and (iv) unnatural or awkward ($n = 5$).

4. Discussion

Before determining how to modify spinal posture among people with NSCLBP, it is important to understand the perceptions of members of the community regarding spinal posture. This is the first study to evaluate the perceptions of people in the community, either with or without NSCLBP, about sitting posture. An overwhelming majority (96%) believed that sitting posture is important in the management of NSCLBP, yet they only occasionally think about their own posture. Participants with NSCLBP thought about their spinal posture more frequently, and thought posture was more important, than those without NSCLBP. As expected, lordotic sitting postures were strongly favoured among participants, although the type of lordotic posture which was preferred was variable. Perceptions on sitting posture across the community did not differ based on NSCLBP status or gender. Among those participants with NSCLBP, perceptions on sitting posture did not differ based on the reported levels of pain, disability or beliefs about NSCLBP.

Perceptions of the community were broadly in line with those reported for physiotherapists (O'Sullivan et al., 2012). While only four of the nine sitting postures had lordotic lumbar angles, these comprised 88% of the best postures selected, which is consistent with the percentage (92%) reported among physiotherapists (O'Sullivan et al., 2012). The fact that they were straight or upright sitting postures was the most common stated reason for preferring postures 9 and 2, and avoiding posture 1. This likely reflects the fact that most recommendations on sitting posture favour lordotic sitting (Harrison et al., 1999), despite a lack of evidence for clear superiority of lordotic sitting over other sitting postures for NSCLBP.

Posture 9 was most commonly chosen (54%) as the best posture by members of the community, which is almost identical to data among physiotherapists (55%) (O'Sullivan et al., 2012). Posture 9 is a relatively "neutral" rather than "end-range" sitting posture, in that it is the third most lordotic in the lumbar region, the third most kyphotic in the thoracic region, and the fourth most kyphotic in overall thoraco-lumbar curvature. While the second most popular posture (posture 2) also involved lumbar lordosis, it is actually very different to posture 9. For example, it is the most extended posture for the thoracic spine and thoraco-lumbar regions overall, and the second most extended in the lumbar region. It also involves forward trunk lean. Therefore, posture 2 may be associated with greater paraspinal muscle activation, fatigue and discomfort (O'Sullivan et al., 2006; Claus et al. 2009a, 2009b).

The greater frequency with which posture 2 was selected as the best sitting posture by members of the community (19%) is the biggest contrast with the data from physiotherapists, where only 5% selected it as the best sitting posture (O'Sullivan et al., 2012). This is not to suggest, however, that posture 2 was a very popular choice among members of the community, since almost as many (15%) selected this posture as the worst sitting posture on the basis of the effort involved in sustaining it, and its unnatural, awkward or uncomfortable appearance. This contrast possibly reflects discussions on weighing up the proposed benefits of upright sitting with the effort involved in sustaining it (O'Sullivan et al., 2006; Claus et al., 2009a). This may explain why posture 9 was described as relaxed ($n = 15$) or comfortable ($n = 12$), whereas posture 2 was never described in such terms by members of the community.

Both genders picked posture 9 as the best posture. While there was a trend for more males to select postures involving more spinal extension (postures 2, 4, 5 and 8) as their best posture, this did not reach statistical significance. However, evidence that gender influences lumbar posture (Smith et al., 2010), body-image awareness

(Muth and Cash, 1997), and perceptions of how painful and harmful spinal movements are (Pincus and Henderson, 2013), suggest that gender is an important factor to consider in studies of spinal posture.

While most members of the community only occasionally thought about their own posture, participants with NSCLBP thought about their posture more frequently, and thought posture was more important, than those without NSCLBP. The increased frequency of thinking about their posture is consistent with descriptions of hypervigilance among people with NSCLBP (Peters et al., 2002). However, the increased focus on their own posture does not seem to have significantly affected their perceptions about sitting posture. This lack of a difference in perceptions about sitting posture between people with and without NSCLBP is intriguing. Considering the reported difficulties among people with NSCLBP in assuming neutral postures (O'Sullivan, 2005; Dankaerts et al., 2006; Sheeran et al., 2012), in repositioning to a neutral sitting posture (Brumagne et al., 2000; O'Sullivan et al., 2003; Sheeran et al., 2012), in perceiving their own body movement and body space (Moseley et al., 2012) and evaluating the perceived harm of tasks using photographs (Trost et al., 2009), it was hypothesised that people with NSCLBP would demonstrate an altered perception of good sitting posture. However, their perceptions were not significantly different to people without NSCLBP. Nor were perceptions of sitting posture significantly different among those with higher levels of disability. This was somewhat surprising since our previous study demonstrated that physiotherapists' beliefs about NSCLBP were related to their perceptions of good sitting posture, with postures involving greater thoracic extension (posture 5) preferred by those with more pessimistic beliefs about NSCLBP (O'Sullivan et al., 2012). The lack of difference may indicate that people with NSCLBP have the same postural beliefs as people without NSCLBP, yet display a specific deficit in determining their own posture due to mechanisms such as altered proprioception, body schema and cortical processing (Brumagne et al., 2000; Bray and Moseley, 2011; Moseley et al., 2012). In other words, it is possible that deficits in their own individual body schema are involved in the distorted postures people with NSCLBP occasionally assume, rather than a distorted perception of how they should sit. To determine this, further studies investigating the ability of people with NSCLBP to accurately detect their own posture from a range of photographs would be of interest.

It is important to highlight that no specific static sitting posture has been shown to effectively prevent or reduce NSCLBP. While posture 9 may have some advantages, a more relevant consideration in advising patients with NSCLBP on posture is likely to be their personal aggravating and easing factors and underlying pain mechanisms (O'Sullivan, 2005; Dankaerts et al., 2009). The reason is that a specific directional sensitivity to movement (Williams et al., 1991; O'Sullivan, 2005) may determine whether more or less seated spinal flexion is indicated. In fact, the ability to gradually vary posture in sitting may be as important as maintaining any specific static posture (Callaghan and McGill, 2001; Telfer et al., 2009) The multidimensional nature of NSCLBP (O'Sullivan, 2012) illustrates the need for clinical management of NSCLBP to consider multiple aspects across the biopsychosocial spectrum, rather than focussing solely on sitting posture.

There are several limitations to this study. While several static, unsupported, sagittal plane postures were considered, many other postures and tasks which commonly aggravate NSCLBP were not considered. The sequence in which the posture photographs were arranged, or other psychological variables, could have influenced the selections made. The variation in spinal orientation between postures with respect to gravity was not quantified. Participants were not given information about the pain status of the model, and were not specifically asked to relate it to their own pain or discomfort if they had NSCLBP. All participants were offered the same range of photographs, to simplify data collection and analysis, and minimise the influence of other confounding variables. The posture selected may have varied with a model of a different body mass index. Similarly, gender has been shown to affect both spinal posture and perceptions of how painful and harmful spinal movements could be. Participants were asked to "select the best posture for the spine as a whole, especially the lumbar spine" in order to reflect that while the focus of our research is on NSCLBP, there is clear interaction between spinal regions in terms of spinal posture. However, allowing participants to select the best posture for each spinal region separately may have offered additional insights. Several factors which could influence posture were not examined in this study such as thoughts and affect, inter-personal communication, and psychosocial factors such as self-efficacy. No clinical information on the model which could influence her spinal range of motion was provided to participants, such as her age or the presence of any pathology. The five point Likert scale used to evaluate participant thoughts on spinal posture has not been validated. The questions used for the qualitative analysis were short, and not validated, but have been used in previous similar research (O'Sullivan et al., 2012). Participants were considered painfree controls if they reported no pain or discomfort in their back in the last 12 months, however we cannot rule out the possibility that they may have experienced some back pain previously. Similarly, the participants with NSCLBP did not undergo a full subjective and physical examination, such that the possibility of them having a "specific" CLBP disorder such as spinal stenosis cannot be completely excluded. We have no information on the amount, and type, of treatment participants with NSCLBP may have received, which could have influenced their choice. Only unsupported sitting postures were considered to allow clear visualisation of the spine, and participant selections may have differed for supported sitting since using a backrest can influence muscle activation and seated discomfort.

5. Conclusion

Before determining if, and how, spinal posture should be modified in people with NSCLBP, it is important to understand public perceptions regarding spinal posture. Members of the community consider sitting spinal posture to be important for the management of NSCLBP, yet only occasionally think about their own posture. Those participants with NSCLBP thought about their spinal posture more frequently, and thought posture was more important, than those without NSCLBP. The majority of participants selected lordotic sitting postures as being optimal, with flexed postures being seen as disadvantageous. Perceptions on sitting posture did not differ based on NSCLBP status or gender. The extent of spinal extension which was considered optimal varied, with very upright postures being selected as the best and worst postures by different participants. The perceptions of members of the community are broadly in line with those reported for physiotherapists.

Ethical statement

Ethical approval was obtained from both a local university Research Ethics Committee and a local hospital Research Ethics Committee.

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