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# Building healthy construction workers: Their views on health, wellbeing and better workplace design

S. Eaves [a], D.E. Gyi [a, *], A.G.F. Gibb [b]

[a] Loughborough Design School, Loughborough University, Leicestershire, UK
[b] School of Civil and Building Engineering, Loughborough University, Leicestershire, UK

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ABSTRACT

Construction is a heavy manual industry where working into later life can be a challenge. An interview study was conducted to explore workers' understanding of their health at work and ways of making their jobs easier, safer or more comfortable. Using purposive sampling, 80 trades' workers were selected from construction sites in the UK. The Nordic Musculoskeletal Questionnaire and Work Ability Index were used to explore aches and pains and reducing strain on the body. A high prevalence of symptoms was reported and ratings of work ability were high. Workers were aware of the physical demands of their work and had over 250 ideas around health and wellbeing e.g. rucksacks for tools, bespoke benches, adapting PPE, and higher cost solutions e.g. mechanical lifting aids. Engagement of the workforce should be encouraged and feed into change processes in the industry to enable all workers stay fit for work for longer.



## 1. Introduction

Construction is a tough, heavy, manual industry where injury and ill health are likely; many workers leave the industry early due to ill health or musculoskeletal disorders (Arndt et al., 2005). This loss of the workforce occurs in the climate of an ageing population in the UK, Europe and globally; Western Europe has one of the oldest populations, with 17% aged over 65 in 2010, and is predicted to increase to 30% by 2060 (Walker and Maltby, 2012). In the UK, it is illegal to discriminate against workers due to their age, so employees cannot be forced into retirement (Equality Act, 2006). This was also supported by abolishing the official UK retirement age (GOV UK, 2014) allowing longer working lives, together with the state pension age rising progressively to 68 by 2046. This has contributed to the prediction that by 2050, almost a third of the workforce will be aged 50 and over (Vos et al., 2008) and it is important that these workers can remain in their jobs for as long as they wish.

The ageing process leads to physiological and cognitive changes which can make working into later life a challenge. This is more difficult in construction with its heavy, manual jobs, indeed the UK construction industry accounts for 27% of fatal injuries and 10% of reported major injuries (Hengel et al., 2012; HSE, 2013). However, remaining in work has been shown to have a positive effect on maintaining social networks and providing a sense of purpose (LeMasters et al., 2006; Damman et al., 2013). The organizational structure of construction sites also makes the job more difficult in comparison to white collar industries, particularly in terms of maintaining a good level of mental and physical health and wellbeing. The peripatetic nature of construction means that workforces are often transient and site locations vary from one job to the next, often requiring early starts and considerable travelling impacting on other members of the family (Riemer, 1979; Earle-Richardson et al., 2005). Construction workers work in dirty, noisy environments with a lack of natural lighting and ventilation; they perform repetitive movements, heavy lifting and work in awkward and cramped positions for extended periods of time. Injury and ill health are often expected to come with the job and research suggests that construction workers are at a higher risk of musculoskeletal disorders in shorter periods of time compared to white collar workers (Arndt et al., 1996; Punchihewa and Gyi, 2009; Järvholm et al., 2014). These conditions are likely to exacerbate natural age-related declines. Principal contractors and employers are responsible for ensuring adequate welfare facilities, personal

* Corresponding author. Loughborough Design School, Loughborough University, Leicestershire LE11 3TU, UK.
*E-mail addresses:* S.Eaves@lboro.ac.uk (S. Eaves), d.e.Gyi@lboro.ac.uk (D.E. Gyi), A.G.Gibb@lboro.ac.uk (A.G.F. Gibb).

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protective equipment (PPE) and general health and safety monitoring (HSE, 2007). Despite this there are still high numbers of early retirements from the industry due to injury and ill health.

Older construction workers are considered to be an asset to the workforce; they are perceived to be dedicated, reliable and produce work of a high quality (Leaviss et al., 2008). There is a high level of respect from younger colleagues, as older workers have spent years learning their trade (Lombardi et al., 2009) and are considered to hold superior trade related skills in comparison to their younger counterparts. However, there is no research quantifying these skill levels, which may be as a result of changes in the levels of qualifications available to construction workers in recent years (Dainty et al., 2005; Lombardi et al., 2009). Historically there are also negative perceptions; older workers are perceived to be difficult to train, slower, and averse to health and safety regulations (e.g. wearing PPE), all concerns in an industry where often time is money (Taylor and Walker, 1994; Loretto and White, 2006; Williams et al., 2011).

Participatory ergonomics is an approach which has been shown to be successful in a number of industries. Within the context of this study it is the theory behind it which is of interest, namely involvement of the end-user in the development of potential interventions, decision making, idea generation and encouraging engagement (Wilson, 1995; Hignett et al., 2005). Previous research suggests that by using elements of participatory ergonomics such as a bottom-up approach together with good management support and key stakeholder involvement, significant benefits can be achieved for workplace, job and equipment design and healthy working behaviours (Rivilis et al., 2008; Tappin et al., 2016). There are fewer recent examples of participatory ergonomics in construction, perhaps due to the peripatetic nature of the work environment and transient workforce. Van der Molen et al. (2005) found that the approach had no significant effect on the use of ergonomic measures in bricklaying companies; however de Jong & Vink, (2002) successfully encouraged installation workers to consider their working practices. Using a participatory approach resulted in 138 new items of equipment and 15 solutions, including a portable fold-out bench to improve posture and an assembly seat to minimise kneeling. Hess et al. (2004) also successfully implemented the approach with concrete labourers using a new device which led to a reduction in the risk of lower back disorders. End-user engagement was also successful in similarly heavy manual industries such as manufacturing. BMW created a pilot production line of older workers who put forward ideas on how their workplace could be improved. 70 changes were made which benefitted both older and younger workers, such as flooring to reduce knee impact, and better seating for rest breaks. Production levels on this pilot line increased and absenteeism dropped providing strong evidence that involving the workforce in changes can help retain older workers and benefit workers of all ages (Loch et al., 2010).

Despite the large number of studies on construction workers' health at work, there are few on their awareness of risks, and maintaining a good level of work ability within their trades. In the context of an ageing workforce, the purpose of this paper is to explore good working practices, behaviours, and ideas for workplace design from the workers' perspective. For this research, 'work place design' is considered to be all-encompassing, including job rotation and the way in which workers carry out their day to day tasks as well as physical design of the workplace. Ultimately the goal is that workers stay fit for work for longer and remain in their jobs for as long as they wish.

## 2. Aims and objectives

In-depth semi-structured interviews were used to explore the extent to which construction workers can contribute to changes in the workplace in order to improve their health and wellbeing. The objectives were:

- To capture the prevalence of musculoskeletal symptoms in workers from construction trades and measure the effect on work ability.
- To explore workers' views on health and wellbeing at work and the factors that might influence these when working in their trades.
- To capture workers' ideas to make their jobs easier, safer, healthier or more comfortable.

This research is part of a larger Age UK funded project to encourage healthy ageing in construction workers. The findings will lead to guidance for the industry on engaging with the workforce to encourage idea generation, communication and facilitate healthy working practices.

### 2.1. Sampling and participants

Sample size was defined considering the peripatetic nature of construction sites and the time available for interviews. A purposive sampling strategy was used as it enables the researcher to satisfy the specific needs of a project and recruit the population of interest (Robson, 2011).

Construction sites and individual workers were recruited through professional and personal contacts. Using snowball sampling techniques from each interviewee, the aim was to recruit 60–80 construction workers. During initial contact with site managers, information was given regarding the inclusion and exclusion criteria of participants: over 18 years old; English speaking; and trades involving heavy manual labour e.g. bricklayers, carpenters/joiners, plumbers and electricians. Care was taken to ensure the sample was as random as possible with site managers selecting the participants from a homogenous group of workers. Participants were grouped in terms of age; under 25, 25–34, 35–49 and 50 and over. Workers aged 50 and over were classified as 'older workers' following many research studies in the UK (Vos et al., 2008). A complete age demographic was included to allow comparisons between older and younger workers. No workers in supervisory roles were interviewed to ensure, as far as possible, that they were exposed to similar working conditions and tasks. Ethical approval was issued by Loughborough University Ethical Advisory Committee in March 2013. Participants were given an information sheet prior to interview explaining the purpose of the study, what was expected of them and their right to withdraw and were asked to sign an informed consent sheet.

## 3. Method

Semi-structured interviews were conducted on site and recorded using a Dictaphone. A flexible 30 min interview schedule was structured around four main discussion points (Table 1) – not all questions were used for all participants. This flexibility allowed for in-depth discussion around topics whilst covering relevant points.

Demographic information included age range, trade and time spent in construction. Participants were asked details about their job to immerse them in thinking about their day to day work and any health risks or concerns. The main focus of the interviews was to ask them to think about their health and wellbeing at work and how their jobs could be made easier, safer, and healthier in terms of ideas for changes to their job and the workplace. Participants were encouraged to think of any improvements that could be made irrespective of feasibility, budget or management constraints to

**Table 1**
Interview structure.

| Discussion points | Questions and prompts |
|---|---|
| Demographics | Age range. Trade. Company/Employer. Site. Time spent in employment. |
| Health | Stage of Change Questionnaire (Whysall et al., 2007)<br>Nordic Musculoskeletal Questionnaire (Crawford, 2007)<br>Work Ability Index (Ilmarinen and Rantanen, 1999) |
| Their job | Day to day tasks. Tools and equipment used. Personal Protective Equipment (PPE) requirements and usage. Location of jobs. Awkward/cramped positions. Use of chemicals. Dust/noise? Risks to health and wellbeing. |
| Ideas for changes to their job and workplace | What ideas do you have to make your job easier and your workplace better?<br>*General ergonomics* – Ideas for new equipment/equipment redesign? Postures? Lighting? Micro-breaks? Job rotation? Order of tasks?<br>*Health and Safety* – PPE e.g. knee pads/gloves/other clothing? Electricians –lighting in confined areas? Bricklayers –issues working outside? Manual handling e.g. plasterer – how do you cope with the weight of the trowel and plaster?<br>*Ageing* – What advice would you give to a younger worker? What would you do differently? What is being done right now to make the job easier/healthier/safer?<br>*Other* – Effects of the weather? Toolbox talks? Workshops?<br>General facilities? |

ensure a wide range of ideas. Prompts and probes were used as appropriate based around the interview topics.

To explore musculoskeletal symptoms experienced a modified version of the Nordic Musculoskeletal Questionnaire (NMQ) was used (Kuorinka et al., 1987) which covers aches and pains in nine body areas. This has been used effectively in many studies (Driessen et al., 2008; Sang et al., 2010; Gosling et al., 2012). Workers were also asked to indicate if they felt these symptoms were directly related to their work to facilitate discussion on any perceived links with working practices. A modified version of The Work Ability Index (Ilmarinen and Rantanen, 1999) was also used to assess workers' self-rated perception of their current ability to work. Workers were asked to rate how able they felt to work (0 – completely unable to work, 10 – the best they have ever worked). Finally, the Stage of Change Questionnaire (Prochaska and DiClemente, 1983; Whysall et al., 2007) was used to facilitate further discussion around workers' openness to change. This helped determine whether workers had considered making changes at work to improve their health and wellbeing. Data was triangulated from the different methods (interviews and questionnaires) and where possible, observations were made on site to add richness and support the interview data.

### 3.1. Data analysis

All interviews were transcribed and analysed thematically in NVivo10, identifying themes and sub-themes. Quantitative data was analysed with SPSS Statistical Software for Windows using techniques including Chi Square, Fishers Exact Test and One Way ANOVA.

## 4. Results

A sample of 90 construction workers was obtained with 80 eligible for analysis based on the inclusion criteria; English speaking, trades such as plumbers, electricians, and bricklayers (Table 2). The majority (n = 74) were from eight sites across three organisations (small maintenance facility, $n = 28$; domestic build company, $n = 30$; large civil engineering company, $n = 16$) – six were obtained through personal contacts.

Trades with less than 10 participants were grouped together under 'outdoor trades' due to their work being mainly outdoors in early construction phases. 'Other trades' were classified as such due to their work activities being required later in the construction process.

### 4.1. Health

#### 4.1.1. Musculoskeletal symptoms and age

To explore musculoskeletal symptoms experienced by workers, data from the NMQ was analysed. Workers of all ages reported a high period prevalence of symptoms in all body areas (Table 3), although older workers (age 50+) particularly reported symptoms in the knees (80%), lower back (63%) and wrists/hands (60%).

There was a statistically lower period prevalence of symptoms in the knees in workers under 25 than the other age groups, perhaps suggesting that the knees are affected by ageing; 31% of workers under the age of 25 reported knee pain in comparison to 80% of workers age 50 and over ($p < 0.01$). Generally there was a lower point prevalence (7 day) of symptoms; older workers reported lower prevalence than younger workers in all but three body areas (wrists/hands, hips/thighs/buttocks and knees). A statistically significant association was found between age and point prevalence of musculoskeletal symptoms in the wrists/hands; 37% of workers aged 50 and over ($p < 0.05$) compared with 23% of workers under 25 reported symptoms.

All workers reported musculoskeletal symptoms in at least one body area in the last 12 months. For each body area, at least 25% of workers attributed their symptoms to work, suggesting that across all ages there were perceived risks of work-related musculoskeletal complaints (Table 4). The middle back appeared to be particularly problematic for workers of all ages and there was a statistically significant association between age and work-related symptoms in the hips/thighs/buttocks ($p < 0.01$); 100% of workers aged 50 and over attributed their symptoms to work compared to none of those aged under 25.

#### 4.1.2. Musculoskeletal symptoms and trade

Due to small sample sizes, 'other trades' and 'outdoor trades' were excluded from the analysis in Table 5. Electricians reported a high period prevalence of musculoskeletal symptoms, particularly in the wrists/hands (63%), lower back (68%) and knees (68%). Plumbers also reported a high period prevalence of symptoms in the knees (68%). There were no statistically significant associations between trades and 12 month prevalence of musculoskeletal symptoms.

The 7 day point prevalence of musculoskeletal symptoms was again high for electricians in the wrists/hands (32%), lower back (32%) and knees (32%). Plumbers also reported high prevalence in the knees (36%). Despite a high period prevalence, fewer carpenters/joiners reported lower back symptoms in the last 7 days; however symptoms were reported in the last 7 days in the wrists/hands (29%), knees (29%) and elbows (21%). There was a statistically

**Table 2**
Age ranges and the mean number of years spent in the construction industry. A trade breakdown of the whole sample is also presented ($n = 80$).

| Age range | Frequency ($n$) | Years in the industry (mean) | Trade breakdown of the sample | $n$ |
|---|---|---|---|---|
| Under 25 | 13 | 5.3 | Plumber | 22 |
| 25–34 | 12 | 8.2 | Electrician | 19 |
| 35–49 | 25 | 21.3 | Carpenter/Joiner | 14 |
| 50+ | 30 | 40.3 | Outdoor trades | 21 |
| | | | Bricklayer | *7* |
| | | | Scaffolder | 4 |
| | | | Labourer | *7* |
| | | | Steel fixer | *3* |
| | | | Other trades | 4 |
| | | | Painter & decorator | *1* |
| | | | Welder | *1* |
| | | | Plasterer | *2* |

**Table 3**
12 month period prevalence (%) of musculoskeletal symptoms and age ($n = 80$).

| Age range<br>Body area | Under 25 | 25–34 | 35–49 | 50+ |
|---|---|---|---|---|
| Neck | 39 | 17 | 20 | 33 |
| Shoulders | 39 | 25 | 52 | 33 |
| Elbows | 15 | 17 | 32 | 27 |
| Wrists/hands | 62 | 50 | 79 | 60 |
| Middle back | 31 | 33 | 24 | 23 |
| Lower back | 62 | 50 | 52 | 63 |
| Hips/thighs/buttocks | 15 | 0 | 12 | 20 |
| Knees | 31 | 50 | 48 | 80 |
| Ankles/feet | 15 | 25 | 24 | 27 |

**Table 4**
12 month prevalence (%) of workers who believed their symptoms to be work related ($n = 80$).

| Age range<br>Body area | Under 25 | 25–34 | 35–49 | 50+ |
|---|---|---|---|---|
| Neck | 60 | 50 | 80 | 50 |
| Shoulders | 60 | 33 | 77 | 80 |
| Elbows | 100 | 0 | 75 | 75 |
| Wrists/hands | 88 | 33 | 91 | 72 |
| Middle back | 100 | 50 | 67 | 100 |
| Lower back | 100 | 67 | 85 | 84 |
| Hips/thighs/buttocks | 0 | 0 | 33 | 100 |
| Knees | 75 | 50 | 75 | 88 |
| Ankles/feet | 0 | 33 | 83 | 25 |

**Table 5**
12 month period prevalence (%) of musculoskeletal symptoms and trade ($n = 55$).

| Trade<br>Body area | Carpenter/joiner | Electrician | Plumber |
|---|---|---|---|
| Neck | 43 | 37 | 27 |
| Shoulders | 29 | 42 | 36 |
| Elbows | 43 | 16 | 14 |
| Wrists/hands | 57 | 63 | 55 |
| Middle back | 21 | 32 | 23 |
| Lower back | 64 | 68 | 50 |
| Hips/thighs/buttocks | 21 | 21 | 9 |
| Knees | 50 | 68 | 68 |
| Ankles/feet | 36 | 26 | 14 |

significant association between trade and symptoms in the elbows – 75% of workers reporting symptoms in the last 7 days were carpenters/joiners ($p < 0.05$).

All (100%) carpenters/joiners who reported symptoms in their lower back and hips/thighs/buttocks, attributed these to work. All plumbers attributed their elbow and hips/thighs/buttocks symptoms to work and 87% attributed their knee pain to work. 85% of electricians attributed their lower back pain to their work.

There were no significant differences between tenure of employment in construction and musculoskeletal symptoms in any body area apart from the knees. The mean length of time in construction for those who reported symptoms in the knees was 28.7 years, compared to 17.2 years for those who reported no symptoms ($p < 0.05$). This may suggest that the longer workers remain in the industry, the higher the risk of knee pain.

### 4.2. Work ability rating

Workers were asked to rate their ability to do their job (0 – completely unable to work, 10 – the best they have ever worked). Using Spearman's correlation coefficient, a significant negative correlation was found between age and work ability (rho = −0.280, n = 80, $p < 0.05$), where workers aged 50 and over had an average rating of 7.9 compared to 9.2 for workers under 25. This suggests that workers of all ages are working at a level they consider to be close to the best they have ever worked. A significant negative correlation was also found between length of time in construction and work ability, whereby ratings decreased with length of time in construction (rho = −0.303, n = 80, $p < 0.01$). There were no statistically significant relationships between work ability ratings and trades. These high work ability ratings indicate workers of all ages feel capable of fulfilling the demands of their job to a high level (the best they have ever worked) but that overall work ability continues to decrease over time.

### 4.3. Ideas for changes to the workplace

Throughout the interview, participants were encouraged to discuss any ideas for changes relevant to them. A template approach was taken to data analysis to allow for key themes to emerge, with a quasi-statistical approach being used to determine the importance of these key themes based on the frequency of their reference. Five themes were formed around the notion of good working behaviours, practices and design in the workplace (Table 6):

#### 4.3.1. Changes that had already been made

The majority of workers of all ages (96%) reported that they had made changes to make their jobs easier, safer or healthier. The most frequently discussed changes (40%) were around good manual handling practices to reduce musculoskeletal symptoms such as keeping their backs straight, bending their knees, getting help from a colleague or using assistive equipment. Workers also spoke about using machinery to help with heavy jobs particularly digging, as it was seen as a way of saving considerable 'labour' and 'preserving their bodies'. Workers had made conscious changes to ensure they

**Table 6**
Themes for improving working behaviours and workplace design.

| Theme | Examples of ideas |
|---|---|
| Changes already made and actively maintained | Good practice in manual handling |
| | Job rotation and job sharing |
| | Use of machinery |
| | Use of PPE |
| | Attending the gym/recreational sports |
| | Taking vitamins and supplements to improve health |
| Changes suggested to improve working behaviours and workplace design | Improvements to PPE |
| | Higher levels of supervision for younger workers |
| | More apprenticeships for knowledge transfer |
| | Toolbox talks with more relevance and impact |
| | Better facilities |
| | Pension schemes |
| New and novel ideas to make the job easier | Workers making their own knee pads |
| | Balaclavas on the inside of hard hats |
| | The 'KISS' method – Keep It Simple Stupid |
| | Attaching cable ties to high vis jackets for easy access |
| | Workers making up their own workbenches |
| | Using toolbags as back supports |
| Discussion around change and improvements in the industry | Health and Safety changes |
| | The potential cost of changes |
| | Management listening to the workforce |
| | Whether ideas would be put in place |
| | Workers' bodies adapt to the work they do |
| | Changes to the culture of the construction industry |
| Dismissal of potential/need for change | Changes are not needed |
| | Companies are already doing all they can |
| | Things have changed too much already |
| | There is too much emphasis on health and safety |
| | Change has not been considered |

remained fit and able to work such as taking regular rest breaks, not pushing themselves to the point of exhaustion and making themselves comfortable in small spaces before beginning a job, illustrating a good level of awareness and consideration for their health and wellbeing at work. Having suitable clothing for keeping warm was mentioned by many workers. Older workers (50 and over) in particular spoke about having an exposed back in cold weather contributing to the development of aches and pains: they often reminded younger workers of the importance of 'covering up' to keep warm in their view 'to reduce musculoskeletal symptoms'. It is unclear whether these changes were proactive or reactive, with older workers tending to attribute changes to their extensive experience in the industry and 'learning from their mistakes' compared to younger workers who tended to have made changes as a result of being taught by supervisors or advised by older workers on site.

> *"I listen to my uncles and my father … they've explained all this to me down through the years … now that I'm getting a wee bit older and a wee bit wiser I think – oh aye, he told me to do that."* (carpenter, age 35–49)

Many workers made changes related to PPE for example, using the required equipment (where previously they had not) and wearing weight-lifting belts to aid heavy lifting. Some changes were trade specific, for example, electricians removing fingertips from gloves to enable them to more easily perform highly dextrous tasks.

Not all changes were directly related to the reduction of musculoskeletal symptoms; workers identified changes to improve their overall health and wellbeing at work and ability to perform well in their trades. Younger workers attended gyms and participated in sport, whereas workers over 35 tended to speak more about physiotherapy or taking vitamins and supplements. One worker (plasterer, aged 25–34), discussed the importance of stretching to warm up before any physically strenuous work but did not share this with colleagues as he was unsure of their response.

Other more general changes included using a rucksack to transport tools to alleviate back pain, keeping workplaces clean and tidy and planning tasks. In several cases, workers acknowledged that construction was a tough industry where injury and ill-health were to be expected. With this in mind, workers felt they were doing their best to look after themselves by acknowledging that good working practices and healthy lifestyles can positively affect their work ability.

#### *4.3.2. Changes suggested*

The majority of workers (80%) had good ideas to improve working practices or the design of the workplace. Over 250 suggestions were captured, ranging from concepts experienced in jobs on other sites, or changes they had thought about but were not yet in place. Again, not all changes were concerned with musculoskeletal symptoms; some were to improve the working environment, health and safety, making it more comfortable, and reducing risks to all workers. Changes to the environment included using hardcore or plastic sheets in muddy areas to reduce slipping hazards, having cleaner work areas and more adequate ventilation. On one site workers suggested very basic but important changes such as better toilet facilities, more toilet roll and hot running water. On another site, a suggestion was to hang ear defenders on the doors of noisy areas (such as generators and boiler rooms), to act as a reminder to wear PPE. Further suggestions included more machinery to alleviate heavy lifting, retirement and pension advice, better supervision of younger workers and more apprenticeships.

#### *4.3.3. New and novel ideas*

Nearly one third of workers had made changes which they believed to be novel and unique to them. Six of these workers were under 25 and seven were 50 and over, suggesting that workers of all ages actively engage in thinking about ways to protect and improve

their health and wellbeing at work.

Just over half of these workers (57%) spoke about PPE, particularly knee pads. The majority did not use the standard knee pads provided for reasons such as not having enough time to put them on if they were on price work, or them being uncomfortable. Instead materials around site were used such as carpet, cardboard or cushions – for better comfort and protection. In two cases, workers created their own knee pad from materials such as lagging or foam (Fig. 1).

Other design ideas included a hard hat which had been distributed to the direct employees of the civil engineering company (not to subcontractors). It had a balaclava attached to the inside so that it was readily available in cold and wet weather and was reported to be very effective (Fig. 2). Many workers (17%), mostly carpenters/joiners spoke about making bespoke benches and jigs to create a more stable work surface at a suitable height, to avoid bending to cut materials, reducing the risk of musculoskeletal symptoms.

> *"We make jigs … I don't think they could (mass) make one cos they're all different sizes you see, they're all bespoke, one-offs …"* (carpenter, age 50+)

Other interesting design ideas included putting a plastic cup around a drill to catch falling dust from the ceiling; fixing a tray around the top of steps to hold a drill; making a portable box to hold small fittings, nails and screws; using tool bags as back supports when doing floor work; putting a head torch under a hard hat as the elastic slips off the hat itself; cutting the length of jackets so that they do not catch on equipment/materials; digging screws into plasterboard at the top of ladders to prevent unnecessary trips up and down; and tying cable ties around the lapel of a PPE jacket to make them easily accessible. There was no judgement by the researchers on the feasibility of these ideas, but nevertheless the range shows thoughtful working practices. The fact that these ideas are unique to the worker and many items of PPE are homemade may lead to a sense of ownership, which could encourage workers to advocate and share these ideas and practices.

#### *4.3.4. Discussion around the notion of change and dismissal of change*

During the interviews, workers were encouraged to consider changes that could be made irrespective of barriers such as management support, time or budget constraints. However several workers initially dismissed this based on these obstacles. The dismissal of change was not always negative; some workers felt that change was not necessary as their workplaces were as 'good as they were going to get'. Many older workers discussed how health and safety had improved over time, particularly relating to PPE and acceptable working practices. However, workers of all ages also felt that regulations had become 'too strict' and often were beyond 'the call of common sense', for example wearing goggles in the rain or hard hats when working on roofs.

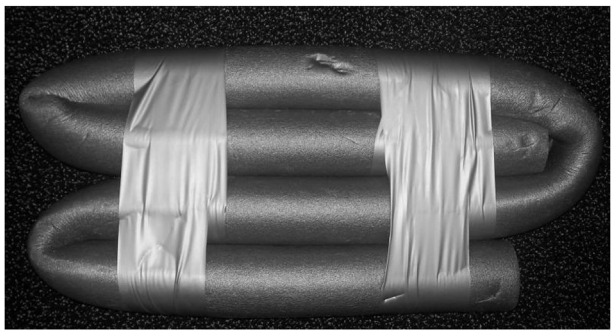

**Fig. 1.** Knee pad made by worker (electrician, under 25).

**Fig. 2.** Hard hat with attached balaclava (joiner, 35–49).

## 5. Discussion

The results of this study show that construction workers of all ages have a high prevalence of musculoskeletal symptoms (12 month and 7 day) which many believed were as a result of their job. Older workers reported a slightly higher prevalence of symptoms in most body areas, although not significantly so (with the exception of knee pain) in comparison to younger workers. This confirms previous research that both age and length of time spent in a manual trade can contribute to an increased risk of musculoskeletal symptoms (Lemasters et al., 1998). Surprisingly, older workers (50 and over) reported less acute symptoms (in the last 7 days) than other age groups in all but three areas of the body, suggesting that it is younger workers (under 50) who are experiencing more acute aches and pains. This could be attributed to the historical 'macho' culture found in construction, whereby older workers are less likely to report ailments for fear of judgement from their peers. This culture on sites has been found to lead to poor working practices such as high levels of physical exertion and an aversion to wearing PPE (Feeney, 1986; Tookey and Chan, 2001; Rawlinson and Farrell, 2008), which could also contribute to the higher prevalence of musculoskeletal symptoms in younger workers. In addition, younger workers reporting more acute musculoskeletal symptoms suggests that neither chronological age nor length of time in construction are sole predictors of this (Koningsveld and van der Molen, 1997; Ilmarinen and Rantanen, 1999; Leaviss et al., 2008). The general increase in symptoms with increasing age is also found in the general population but construction workers in heavy manual trades are likely to experience more severe symptoms and exacerbated age-related declines within a shorter period of time in comparison to white collar workers and the general population

(Arndt et al., 1996; Järvholm et al., 2014; McMahan and Chikamoto, 2006).

Reports of musculoskeletal symptoms in the last 7 days were high for electricians in the wrists/hands, lower back, knees, ankles/feet. However, other research involving electricians has found more reports of complaints in the upper arms, elbows and shoulders (Örtengren et al., 1991; Moriguchi et al., 2013). This discrepancy may be due to better equipment such as lighter, cordless power tools which reduce the risk of overloading the upper extremities during tasks such as drilling. In addition, more than half of the electricians interviewed attributed symptoms to their work which is consistent with recent research and suggests that they suffer from aches and pains during the working day (Inaba and Mirbod, 2010). Carpenters/joiners suffering from work-related lower back pain and plumbers work-related knee pain is also consistent with previous research and due to the nature of the work tasks (Punchihewa and Gyi, 2009). The high numbers of workers believing that their musculoskeletal symptoms were a direct result of work suggests that more research is needed concerning design in the workplace. However, a number of workers felt unable to attribute work as a direct cause and instead suggested a combination of, activities outside of work, the heavy nature of the job, getting old, and wear and tear was more likely.

Interestingly there was a strong relationship between the length of time in construction and workers experiencing knee pain suggesting that the knees are susceptible to deterioration over time (although this has not been widely investigated). The high number of reports of knee pain may have also contributed to the popular discussion around knee pads and the use of materials such as foam, carpet and cushions by workers to reduce discomfort and protect their knees. Workers may be reducing their likelihood of symptoms by reducing the pressure on the knees when working at floor level, which has been shown to cause prepatellar bursitis (housemaid's knee). In addition, workers who reported novel ideas such as making bespoke benches and jigs may be reducing their risks of musculoskeletal symptoms in the upper limbs and back. Kee and Karwowski (2001) found that discomfort is significantly affected by posture and that posture holding times are negatively correlated with postural loading, such as that experienced by carpenters when preparing materials on benches at an inappropriate height.

The large quantity of design ideas and modifications suggested, illustrates that these workers were mindful of healthy and safe behaviours, and saving strain on their bodies. This creativity and understanding echoes the findings of the pilot BMW production line, where workers were consulted about their ideas for improvements to reduce physical and mental strain; 70 changes were made suggesting that involvement of the workforce in developing solutions can lead to positive change (Loch et al., 2010).

The decline in work ability ratings with increasing age supports the notion that the older construction workers may not find work as easy as workers of a younger age; this has been found consistently in previous research (Ilmarinen et al., 1997; Liira et al., 2000; Williams et al., 2011). The findings are similar to those found in other work groups, such as white collar workers, commercial service workers and home care workers (Van den Berg et al., 2008; Pohjonen, 2001). However, a steeper rate of decline in work ability has been shown in construction with increasing age (Capanni et al., 2005). It is important to note that the overall high average ratings demonstrates that these workers considered themselves to be fit, able to work and keen to remain in work.

Workers' use of non-mainstream PPE such as weight-lifting belts, coupled with a conscious effort to stay fit and healthy outside of work demonstrates willingness to put in extra effort to ensure they are able to work to the best of their ability and for as long as possible. Many workers spoke about how they had joined gyms, were eating healthily and taking supplements such as cod liver oil, demonstrating knowledge and awareness of how their general health can impact their performance. Previous research has found that lifestyle factors are associated with perceptions of work ability, suggesting that if workers keep fit and healthy outside of work they will feel more able to work (Van den Berg et al., 2008).

Ideas for improvements/changes in the workplace came from workers of all ages suggesting that experience and knowledge can be drawn from the workforce as a whole. This provides a sound basis for a participatory ergonomics approach in the construction industry; workers have good ideas/solutions to problems and are keen to share/discuss them. In previous research, the creativity and enthusiasm of the workers in manual teams has been harnessed in a variety of ways such as idea books and boards where workers write down ideas or post them up on cards (de Jong and Vink, 2002; Loch et al., 2010). More recently in keeping with modern technology, a smartphone app was trialled where employees could message an online portal with suggestions and ideas (Davies and Harty, 2014).

### 5.1. Limitations

A limitation of the findings (particularly with regard to the prevalence data) may be due to the 'healthy worker effect' whereby workers available on site for interview were inevitably not significantly affected by musculoskeletal symptoms or other health problems to the point of being unable to work. This means that reports of symptoms may be even higher in the workforce. This effect has been identified in other heavy manual industries, where workers suffering with severe musculoskeletal symptoms were no longer fit to be on site (Dement et al., 2009; Shephard, 1999; Cook et al., 1996).

A purposive sampling strategy was used whereby site managers were asked to identify workers of all ages in specific manual trades. Although a relatively small sample, care was taken to ensure that it was as representative and random as possible within the constraints of the peripatetic nature of construction sites and the time constraints of the workers. Despite this there may have been uncontrollable selection bias via the site managers, such as them selecting receptive individuals. However, there was a wide variety of participants interviewed and interviewees seemed unrestrained in their responses, therefore although the sample may not have been fully representative there was a large range of views expressed.

Unfortunately in the majority of cases, direct observations (taking photographs and videos) were not possible due to supervision requirements on construction sites which limited the researcher in becoming fully immersed in the construction tasks. The researcher did however make particular efforts (through questionning) to become as immersed as possible in the trades of the participants.

## 6. Conclusions

In common with several other research studies it was found that construction workers are at a high risk of injury, ill health and musculoskeletal symptoms as a result of their work. Different trades reported different symptoms for example, electricians (knees, lower back), carpenters (lower back), and plumbers (knees). This research also confirmed that although workers experience a number of aches and pains as a result of their work, this did not affect the work ability of individual workers.

The wide range of ideas and thoughtful working practices described indicate that the construction workers involved in this research were very aware of the physical demands of their job, their

health at work and took some personal responsibility. In addition, workers of all ages had good ideas to reduce physical and mental strain on their bodies and in particular the risk of musculoskeletal symptoms. Older (often more experienced) workers in particular have a wealth of knowledge and experience and it is important that this is retained.

The study has demonstrated that workers can be engaged and encouraged to share ideas to improve their health at work. Involvement of the workforce in developing solutions/decision making can lead to positive change and managers and supervisors should consider ways of encouraging this. Participatory ergonomics could enable sharing of good practices between workers and across the industry. Management support is an integral part of this process and it is important that all stakeholders are involved in discussions such as feasibility, implementation and cost. This will be explored in more detail in a subsequent study together with opportunities and barriers to making effective change.

It has been shown in previous research that ideas from the workforce can lead to an increase in productivity, therefore stakeholders in the industry should be taking advantage of the wealth of knowledge and experience held by workers of all ages.

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