The identification of the domestic waste collection system associated with the least operative musculoskeletal disorders using human Resource absence data

Abstract

With increasing pressures around public sector costs, UK Local Authorities (LAs) and waste collection companies, are under pressure to reduce absence rates due to ill health. The identification of the 'safest' method of waste collection in the UK has been largely unresolved with many different types of waste and recycling receptacles used and deemed acceptable. The purpose of the study was to investigate the relationships between domestic waste collection methods and absence due to Musculoskeletal Disorders (MSDs) through the comparison of absence rates for different activity. Studies based upon ergonomic theory had suggested the use of wheeled bins is better than the use of boxes, but this has not been tested empirically.

Absence data was obtained from 15 LAs who allocated a more detailed activity role to their records, allowing for activity absence rates to be calculated. The outputs were collated and analysed using SPSS to identify statistically significant relationships between types of waste collection services. The results confirm that wheeled bins are associated with less proxy measures of MSD than boxes, baskets and sacks with even lower absence rates associated with 1100 litre capacity bins, when handled by two workers. Findings also indicates that there is a level where MSD absence interventions are unlikely to be sustainable.

In conclusion these findings should help LAs better understand some critical factors regarding waste collection strategies and MSD absence and inform HSE enforcement strategies. Employers should interrogate their own ill health data and seek to move to systems that create less MSDs.

There are 6 recommendations including for further study and for industry and practice.

1 Introduction

1.1 Overview

One of the greatest challenges in the UK waste collection sector has been to identify the least harmful ways of collecting domestic waste. This study suggests a method to help identify relationships between work and ill health absence (IOSH 2015) to improve health and safety (H&S) working conditions.

Local Authorities (LAs) in the United Kingdom are required to collect household waste (LGU 1990), each one is legally required to assess and minimise risks to an acceptable level before the implementation of new collection systems (HSE 2009a) and have a choice with regards the collection system (Mills & Andrews 2009)

The waste sector is one of the UKs most dangerous having a major accident rate 4.1 times that of all industry (HSE 2018, HSE 2012, & Bomel 2004), with significant health risks around manual handling leading to Musculoskeletal Disorders (MSDs) (Kuijer 2002 & Garrido et al 2015). HSE (2013) define MSD as any injury, damage or disorder of the joints or other tissues in the upper/lower limbs or the back. Work in the waste sector is physically demanding with operatives each walking over 10km and handling between 10 tonnes (Pinder & Milnes 2002) and 16 tonnes of waste per day (An et al 1999). Westgaard & Winkel (1997) suggest both work and non-work factors act together to create MSDs, with Froggett (2010) suggesting MSDs are often made worse by work and impair the ability to work at normal capacity.

Holmes (2009) identified that waste and recycling employees identified as drivers, loaders or operators had an average of 13.2 days absence per year. Naylor (2014) identified annual absence of working and recycling workers of 10.3 days absent per year with the CIPD (2018) stating an average level of employee absence in UK industry as. 6.6 days per employee per year. This suggests that the sector has higher absence rates than other sectors.

This is the first paper to compare actual absence rates of different waste collection activities rather than ergonomic theory(Pinder &Okunribido 2019, Ziaei et al 2018, and

Garrido et al 2015), and therefore of interest to both waste policy makers and Human Resource Managers with responsibility for absence management strategies. HSE (2015) suggest the importance of routinely analysing sickness absences to improve working conditions. The authors have assumed that all employees subject to this study are deemed to have been assessed as being individually capable of carrying out their assigned roles consistent with UK employment law (Saranga et. al. 2017).

The use of waste collection systems that are associated with the least amount of MSD is the first workplace intervention necessary as identified by Garrido et al (2015). Many LA risk assessments carried out before the introduction of boxes to segregate glass from co-mingled systems do not adequately identify the risks, tend to be qualitative and do not offer risk protection (Warburton 2019, Hughes 2018, Lamb 2013, Read 2013, Anastasi 2013). With some authorities' still adopting source /semi sourced segregated boxed collections (Date 2016), other LAs have moved to co-mingled collection in wheeled bins (Slow 2019, HSE 2011).

This study sought to compare absence rates of staff carrying out different waste collection activities. The null-hypothesis was that there was no difference in absence rates between different methods of collection. The aim was therefore to 'find the waste collection system associated with the least operative MSD absence using HR absence data'. It was vital to ensure that the methods used could be adopted by individual employers and in a form where comparison between employers could be made. Through adopting a process using group data it was possible to avoid the identification of individuals (UKG 2018), something that has made the availability of ill health data difficult. By understanding the real health risks rising out of work it is possible to redesign work to reduce their impacts and create a more sustainable workforce. Previous studies (Poulsen et al.1995) had identified associations between waste sorting and recycling, hence the need to increase knowledge to prevent occupational health problems when new waste collection systems are developed.

What limited studies into health that are available are limited to environmental and public health issues (Woon and Lo 2016) with those studies looking at waste strategies often excluding human resource factors (Bartolacci et. al. 2019).

With England looking to standardise waste collection (UKG 2019) to simplify and improve household recycling (Romano et. al. 2019 and Meng et. al. 2019), there is importance in ensuring that there is appropriate Health and Safety knowledge making this paper timely and welcome.

1.2 Background

There are two key factors at play regarding waste collection methods and MSD prevalence:

(i) how LAs set waste strategy,

(ii) the lack of understanding of the relationship between that strategy and the MSD risk factors.

There is often a disconnect between these and implementing findings from research; the implementation of research is often of limited use because of generality with arguments often focused on accidents.

Waste strategy is driven by increasingly stricter interpretation of EU waste directives leading to segregated collections (Ottery 2013). The UK Government requires each household to have a minimum of three different segregated collections to increase recycling rates, with more demanding requirements for source-segregate recycling in Scotland (Scottish Government 2012). The recycling supply chain has incentives for uncontaminated materials, making kerbside sorting into ‘clean’ uncontaminated distinct types appear financially rewarding, providing lowest cost for maximum recycling (Williams & Cole 2013).

This has led to a diverse range of containers being used to contain (mainly kerbside collected) household waste including food waste (Bees &Williams 2007) ranging from different sized wheeled bins, smaller containers and plastic bags (Poulsen et al. 1995),

each of which has its own manual handling issues (Pinder & Milnes 2002 and Qureshi et al. 2007).

Secondly, there is poor evaluation of the manual handling risk factors created by recycling activities undertaken in Great Britain Bomel (2009). Bomel (2009) also identified that the UK Health and Safety Executive (HSE) recording categories were inadequate making studies in this area difficult.

Studies by Pinder and Milnes (2002), Hollett et al. (2009), and Oxley et al. (2006) identified that the use of wheeled bins reduces the risk of manual handling injury, compared to handling non-wheeled containers and the decanting of boxes into vehicles when kerbside sorting. Wheeled bins are therefore preferable to boxes and baskets and, where used, boxes should not exceed 40 litres, have lids and must be lifted by two hands. These studies were confined to relationships between accidents and waste systems rather than ill health arising out of work activity. Hollett et al. (2009) also identified issues with throwing bags up to 3m in the air into vehicles.

MSD research invariably involves some analysis of pain (Thomas et. al 2018). McGill (1997) identified three key scenarios that usually interact together to cause pain; 'Single Exertion', 'Static Loading' (e.g. posture), and 'Repetitive Wear and Tear'. These work in combination, albeit differently, in each of the key elements of waste collection systems that include:

- Collecting and sorting into constituent parts (e.g. paper, plastics, metals etc.) from boxes and baskets at the kerbside,
- Transportation of co-mingled material to centralised premises, such as Materials Recycling Facilities (MRFs), for sorting and or processing,
- Separate garden waste collection,
- Separate food waste collection service (through 30 Litre (L) wheeled bins),
- Collection of the above or trade waste in 1100 L bins.

Collections of waste in 1100 L bins tend to:

- be less frequent, with travel between one or more collection points,
- require forces within individual capabilities (Kuijer et al 2010) when a team of two operatives should be used rather than collections with a single worker
- allow for breaks in activity reducing the effects of prolonged static loading.

These different systems create different MSD risk profiles (Ziaei 2018) with Wai et al. (2010) identifying association between bending and twisting, awkward occupational postures and low back pain. Widanarko et. al. (2011) found that there was an association between industrial physical risk factors and absenteeism due to lower back symptoms of the individuals working in industry.

There are also risks for drivers; Pillastrini (2009) investigated postural static loading and identified relationships between sitting and Lower Back Pain, suggesting issues when seated for prolonged periods. Kuijer (2002) noted that truck drivers are also exposed to whole body vibration, made worse with worn suspension created by 'non metalled' roads on landfill sites.

In combination, these factors create difficulties carrying out risk assessments and carrying out research. Holmes (2009) identified problems obtaining data due to limited resources and difficulties accessing data in a suitable form but suggested waste and recycling employees have more days absent than other public sector employees. Additionally, the increased use of temporary (agency) staff across the sector (Toyer 2015) with ill health records held by the agency and not the LA, suggests the possibility of absence rate under reporting (Mason & Matthews 2013).

Some LA's have carried out detailed evaluations of H&S issues arising from boxed collections. Parry (2008) & Thomas (2006) identified maximum box weight was above the suggested limits of approximately 13kg for men and 7.5kg for women (Oxley et al. 2006) likely to cause damage to the back". Van der Beek et al. (1999) carried out studies of wheeled bins with an inserted top caddy and tray and noticed significantly higher compressive forces on the lower spine than placing the box on the ground to reduce

bending. Walker (2012) recommended smaller kerbside boxes rather than using a caddy that drops into the top of a wheeled bin.

Fylde Borough Council (Oldfield 2008) reported high sickness absence rates (25.13 days/employee) with a service containing box and basket collections giving a 50% recycling rate, eventually moving to a wheel bin service. Some LAs were less robust in their evaluation of the risks arising out of glass collection, either underestimating the risks (Read 2013, Lamb 2013) or failing to evaluate the risks (Anastasi 2013). Thomas et al. (2018) confirmed that although employees were active outside of work there was no statistical difference between work groups for each non work activity identified through return to work interviews.

Henry (2010) suggested high MSD absence was associated with the collection and kerbside sorting of boxes and baskets and compared MSD absence arising out of the different domestic recycling systems due to different collection methods and receptacles available. Henry (2010) focuses on types of receptacles used rather than type of waste collected thus dictating the size, weight and manner of moving each load of waste, which is highly relevant to MSD.

Yang (2001) confirmed that bagged collections present a risk for the development of self-reported 'low-back' pain with Ziaei (2018) identifying that 92.5% of waste collectors reported MSD symptoms in at least one body region in the previous 12 months. Fisher (2018) reported that 50% of workers reported having a musculoskeletal injury; and 33% reported a lack of support from co-workers or supervisors, Garrido et al (2015) identified back pain was reported by 67.2 %, with other musculoskeletal complaints reported by 15.4 % of the workforce.

Most injuries occur to upper and lower extremities and the back. Jeong (2016) focused on fatalities and injuries in Korea using national data with more than 4 days of absence identified 7.9% of accidents were attributed to MSDs with Jeong et. al. (2016) identifying that 11.1% of injuries and illness are MSDs.

Jeong et al (2016) identified a need for policies and guidelines for preventing workplace injuries and work-related ill health with Kuijer et. al. (2007) suggesting that a paradigm shift in how LAs view ill health absence is needed, moving to matching physical ability to healthy work activities.

Feuerstein et al (2003) identified that those with pre-existing injuries recruited into manual work are likely to suffer deterioration presenting challenges when rehabilitating people with existing injuries. Finally, Burton et al (2006) suggest that back pain cannot be prevented, suggesting that employers' strategies need to be around accommodating people with backpain.

In summary the main issues are:

- The waste sector has higher absence rates than other sectors
- Waste collection methods do not always use the theoretically lowest risk systems of work
- A reluctance by waste sector employers to accept the connection between work and ill health without quantitative evidence.

The main knowledge gap displayed in current literature is around the lack of comparable MSD absence data for different systems of work with one of the biggest barriers engaging with employers, hence making interventions whilst protecting jobs difficult (McHugh 2001).

2 Materials and Methods

The study required access to LA ill health absence data covering both MSD and Non-MSD. By doing this it would be possible to compare absence rates and see if there were differing patterns; it was important to have access to authorities carrying out different methods of refuse and recycling collection. This would also help in reducing the effects of different management regimes and other service differences and allowing for statistical comparisons to be carried out.

The study adopted the industry standard classifications of ill health absence used by Holmes (2009) and Naylor (2014) allowing for comparison between other authorities and industries and to find common patterns. The method used is summarised in Figure 1.

The first challenge was to contact UK LA service providers, both in house and contracted out as participants. The main contracted out companies were unwilling to participate and so approaches were made to 63 local authorities across the UK out of 180 with an in-house service. This was therefore a sample of convenience (Lund 2012), where known contacts are used to obtain data (Handcock & Gile 2011). A nominal 37 ½ hour week over 5 shifts was assumed excluding agency data not held by the local authority. By 2016 many authorities had moved to 4 long days allowing for a 5th day on overtime for garden waste collections giving increasing exposure to risk factors Over 750 individual entries were obtained.

The study divided the number of days of absence by the number of employees required daily to create a common metric. A modified version of the data collection model for the HSL research (Holmes 2009) was used with LAs asked to record each employee's period of absence on an excel spread sheet recording, date, period of absence and generic role such as, loader, driver, fitter, landfill etc., together with the ill health reason, MSDs, Mental Health, headache/migraine etc. This study also asked for the predominant role/type of waste collection work undertaken over the 12-month period by each employee as identified by their manager.

To eliminate differences in recording absence and shift pattern, councils also confirmed how many staff were needed on any operational day. Thus, an absence rate stating days off/employee could be calculated for each work activity using a common comparative calculation with the addition of a summary of the predominant type of waste collection work undertaken over the 12-month period by each employee as identified by their manager.

Absence rates using the above were identified for work categories (loaders and vehicle, drivers, type of work activities (sacks, recycling baskets and boxes, wheeled bin

collections, 4 wheeled 1100 L bins and driving) and absence type (MSD and other absences).

Requests to operations managers in Local Authorities in all regions of the United Kingdom were made. Requests were both in person and by phone followed up by e-mail requesting information covering one or more 12-month period(s) to coincide with financial reporting periods April 1st to March 31st. Full support was given by the authors to ensure that the correct information was obtained. This information allowed comparisons to be made covering several years although not as a formal longitudinal study (each year was a separate case). 'No responses' were followed up periodically after the initial request. Useable data was received from 15 authorities and collected between 2010 and 2014.

Data was obtained inputted into Excel and transferred into SPSS: it compared each authority and summarises the following:

- The reference period (years and periods)
- overall days off per employee
- days off per employee for drivers and loaders
- days off per employee for MSD/backpain and 'other absence'

Data was analysed on a staged basis from high level data to more detailed work activity in the following ways:

(i) The comparison of pooled absence rates – days off/employee, 'high level' data, comparing the overall absence rates for each collection system.

(ii) The comparison of absence with collection systems due to type of ill health - days off/employee, the 'high level' data split into back/msd absence and other absence.

(iii) Comparison of absence with employee role due to types of ill health – days off/employee, absence rates were compared between different work activity for both backs/MSDs and other absence for all work groups.

(iv) Comparison of absence with employee role due to types of ill health (Loader Activity Only) – days off/employee, comparing absence rates excluding drivers to

statistically compare different loading activity between different work activity for both backs/MSDs and other absence for all work groups.

The statistical software package SPSS was used to compare absence rates of different collection methods. This included the creation of comparison box plots which compared average time off/employee, maximum and minimum values and identified selected. marked and ignored outliers. Where SPSS indicated insufficient sample size due to the classifications chosen, broader reclassification was used.

Visual inspection of graphical data was undertaken to identify any possible linear relationship with the use of boxplots (NZGov 2018) data could be graphically shown. All, results were sorted into four equal sized groups from the ordered scores with 25% in each group. The lines dividing the groups are called quartiles, and the groups are referred to as quartile groups. The median (middle quartile) marks the mid-point of the data and is shown by the line that divides the box into two parts. Where the box plot is comparatively short it suggested that overall results have a high level of agreement with each other.

Statistical evaluation was based upon standard hypothesis testing and based upon 95% confidence levels and included:

- a test for statistical normality using Kolmogorov-Smirnov and Shapiro-Wilk tests. followed by
- a test using one-way ANOVA (Analysis of variance) if there was a parametric distribution,
- where an alternative hypothesis was identified a further post-hoc test was carried out, tests for the assumptions of equal variance assumed (Tukey, Boneferroni and Scheffe) and not assumed (Tamhane T2, Dunnwtt's T3 and Games-Howell) were carried out,
- a Kruskal Wallis test was used instead of ANOVA, where the test of normality indicated that distribution was non-parametric, together with a Mann Whitney post-hoc test using a Bonferroni adjustment.

In all cases a 'null hypothesis' was assumed that there was no significant difference between collection systems with any observed difference being due to sampling or experimental error.

There were potential ethical issues with regards access to absence data and it was agreed not to identify the authorities who agreed to take part in the study with no individual able to be identified.

3 Results

The process implemented confirmed that the categories used in this study could be mapped with categories used by Holmes (2009) & Henry (2010) and consequently used as a foundation for the study with some authorities having additional sub-codes to reflect the parts of the body affected. Those authorities whose recording systems identified 'combined neck and back absence' couldn't easily be compared or benchmarked with those who identify 'back absence' only (usually lower back in the lumbar region) and neck pain. Comparisons were therefore made using the average absence rates for all MSD's, including backs, as one figure.

(i) The comparison of pooled absence rates – days off/employee

Comparison of all absence

Figure 2, the pooled data for all employees, shows that those authorities whose collection systems comprise wheeled bins only have lower absence rates than those with recycling systems including sacks or boxes/baskets. Authorities with services that exclude boxes and baskets and collect all material in wheeled bins have the lowest absence rate.

There was a statistically significant difference between groups as determined by one-way ANOVA ($p = .034$). A Tamahane post-hoc test revealed that the average days off per employee were statistically lower when comparing wheeled bin only services and those systems combining wheeled bins with boxes ($p = .029$). There were no statistically significant differences between those services comprising wheeled bins and sacks, and wheeled bins and boxes ($p = .684$), nor wheeled bins plus sacks and wheeled bins

(p=.116). A Dunnett T3 post-hoc test revealed that the average days off per employee were statistically lower between wheeled bins and wheeled bins with boxes (p = .029). The average absence rate for employees whose authorities' collection system includes collections using boxes and baskets is higher than those without. Post-hoc tests indicate that the alternative hypothesis should be considered true, that there is a statistical difference between those services comprising wheeled bins only and those whose services included wheeled bins and recycling with boxed collections.

Figure 3 compares the pooled data used by authorities for loading staff. The absence for services using only wheeled bins is lower than those services using boxes baskets and wheeled bins. The distribution is normal (>0.05) with ANOVA (SPSS) used to test for significance and any post-hoc tests.

There was a statistically significant difference between groups as determined by one-way ANOVA (p = .037). A Games-Howell post-hoc test revealed that the average days off per employee were statistically lower between wheeled bins and wheeled bins with boxes (p = .050). There were no statistically significant differences between the wheeled bins plus sacks and wheeled bins with boxes (p = .391), nor wheeled bins plus sacks and wheeled bins (p=.146).

Absence data for those whose predominant activity is Driving (Figure 4) shows lower absence rates for those systems that included wheeled bins and sacks and loader-drivers (wheeled bins) with the highest levels for wheeled bins and boxes. The data for wheeled bins with bagged collections for significant parts of the service is based upon only two results and caution should be applied due to the small data set for this collection type. The distribution is normal (>0.05) with ANOVA (SPSS) used to test for significance. Carrying out an ANOVA test with SPSS produced a significance level of 0.222 suggesting that the 'null hypothesis' (H_0) can be assumed with no further analysis required.

(ii) The comparison of absence with collection systems due to type of ill health - days off/employee

Comparison of Backs/MSD absence

Comparison of absence rates of pooled data used by authorities is shown for 'Backs and MSDs' (Figure 5) and 'Other Absence' (Figure 6). Figure 5 shows that there is more absence due to back and MSD injuries for collections with wheeled bins, boxes and baskets than those solely using wheeled bins.

Statistical analysis suggests that the distribution is normal (>0.05) with ANOVA (SPSS) used to test for significance. There was a statistically significant difference between groups as determined by one-way ANOVA ($p = .046$). A Tamahane post-hoc test revealed that the average days off per employee which is lower between wheeled bins and wheeled bins with boxes ($p = .010$). There were no statistically significant differences between the wheeled bins plus sacks and wheeled bins with boxes ($p = .957$), nor wheeled bins plus sacks and wheeled bins ($p=.362$). A Dunnett T3 post-hoc test revealed that the average days off per employee were lower between wheeled bins and wheeled bins with boxes ($p = .010$). There were no statistically significant differences between the wheeled bins plus sacks and wheeled bins with boxes ($p = .937$), nor wheeled bins plus sacks and wheeled bins ($p=.285$). A Games-Howell post-hoc test revealed that the average days off per employee were lower between wheeled bins and wheeled bins with boxes ($p = .009$). There were no statistically significant differences between the wheeled bins plus sacks and wheeled bins with boxes ($p = .875$), nor wheeled bins plus sacks and wheeled bins ($p=.247$). The Tamahane post-hoc test shows that back pain/MSD absence for wheeled bin collections is significantly lower than those with elements of the service that include boxes and baskets.

Figure 5 shows that employee absence for services using box baskets and wheeled bins is higher than for services using only wheeled bins. The data set for services using predominately bagged collections was of insufficient sample size for meaningful comparisons to be made, suggesting that when employees have a more physical job and are feeling unwell with a virus or outside work in the wet etc., they are less inclined to come into work. Statistical analysis indicates that the distribution is normal (>0.05) with ANOVA (SPSS) used to test for significance. Absence for wheeled bin collections is lower than for those who collect both boxes and sacks. ANOVA produced a significance level of

0.217 suggesting that the 'null hypothesis' (H_0) can be assumed with no further analysis required.

When comparing the average MSD absence rate for pooled data for boxes and baskets collections with those handling wheeled bins, Table 2, it is greater for both drivers (15.3 against 10.7 days per employee) and loaders (18.4 against 14.63 days per employee).

The activities with the lowest absence rates for MSDs are drivers and loader/drivers carrying out 4 wheeled bin collections. The high result for Loaders is affected by the very high figure (105 days/off per employee (all absence) and 96.5 (MDS's) at one authority and without this figure the pooled result would be far lower. Typically, 1100 L bin-collection for trade waste alone are not a major element of LA services, being a chargeable service exposed to open competition from other service providers. Therefore, care should be exercised when interpreting these results.

When comparing days off per employee for all absence (all employees) and type of service, Statistical Analysis indicates that the distribution is normal (>0.05) with ANOVA (SPSS) used to test for significance, with only one entry indicating the possibility of a normal distribution not being applied. Those collecting 4 wheeled 1100 L bins have the lowest absence rates with the highest absence rates for staff handling wheeled bins with side waste and loaders handling boxes and baskets. The ANOVA test (SPSS) produced a significance level of 0.110 suggesting that the 'null hypothesis' (H_0) can be assumed with no further analysis required.

(iii) Comparison of absence with employee role due to types of ill health – days off/employee

When comparing MSD absence rates for all employees for different types of service (Figure 7), the absence rate for loaders working with baskets and drivers and loaders working with wheeled bins was similar. The activity with the widest standard deviation is absence for those loading with only bags and sacks followed by those handling recycling boxes and baskets.

When considering collection using wheeled bins alone they have a smaller standard deviation showing more consistent results, less variability, therefore more confidence that this method of waste collection results in less absence. It was difficult to compare 1100 L bin collections, due to low frequency and in some cases a non-statutory service the LA do not provide. Key findings were that those collecting 4 wheeled 1100 L bins had the lowest absence rates and services with wheeled bins services that permit side waste and loaders handling boxes and baskets had the highest absence rates. A normal distribution was found (<0.05) and the Kruskal-Wallis Test (SPSS) was used to test for significance. Carrying out the Independent Samples Kruskal-Wallis Test produced a significance level of 0.008 suggesting that the 'null hypothesis' (H_0) cannot be assumed and that it is likely that there is a statistically significant difference between the variables. A Mann Witney post-hoc test gives a relationship of 0.002 between Driver and Driver-Loader (4 wheeled bins) and Loaders (boxes and boxes/baskets). (The Bonferroni Adjustment for a k value of 7 gives 0.05/21 = 0.0024, rounded down to 0.003). The Mann Witney post-hoc test between loaders of wheeled bins and loaders using boxes and boxes/baskets is 0.008 and not statistically significant.

When comparing the absence rates for absence other than backs and MSDs (all employees) and type of service identified the lowest absence rates were for 4 wheeled trade bins. The highest overall absence rates were for staff carrying out wheeled bin collections with statistical analysis identified a normal distribution (< 0.05) with ANOVA used to test for significance producing a significance level of 0.208 suggesting that the 'null hypothesis' (H_0) can be assumed with no further analysis required. This information suggests that although there is no significant difference between different activities with regards general absence it appears that rates are lower for employees carrying out 1100 L bin collection services.

(iv) Comparison of absence with employee role due to types of ill health (Loader Activity Only) – days off/employee

Figure 8 compares the absence rates for loaders and loader/drivers indicating the activities with the lowest absence rates exclude the collection of boxes, bags or baskets. There was difficulty segregating boxes and baskets data due to staff moving between activities (and in some cases mixed services) so they were combined into one group for analysis. With 8 out of 9 indicators suggesting a normal distribution (< 0.05); ANOVA (SPSS) was used to test for significance. The highest overall absence was both for loaders with wheeled bins and also loaders having collecting recycling in boxes and baskets. The ANOVA test was not significant with a significance level of 0.358 suggesting that the 'nul hypothesis' (H_0) can be assumed with no further analysis required.

Figure 9 shows that the two work activities with the highest absence rates are when collecting wheeled bins with side waste and with recycling using boxes and baskets. With 4 out of the 9 indicators suggesting a normal distribution (<0.05); the Kruskal-Wallis Test (SPSS) was used to test for significance. This produced a significance level of 0.060 suggesting that the 'null hypothesis' (H_0) can be assumed and that it is unlikely that there is a significant difference between both variables.

Figure 10 compares absence excluding back injury and MSDs with work activity identifying the lowest absence rates are for loaders who empty 1100 L capacity 4 wheeled bins, although there is one extreme outlier. This extreme outlier was due to a small workforce in one authority having an employee with a period of long-term absence. It suggests that the work with lowest absence rates for boxes and baskets is the collection of 1100 L capacity 4 wheeled bins. With 7 out of 9 indicators suggesting a normal distribution (< 0.05) ANOVA (SPSS) was used to test for significance producing significance level of 0.201 suggesting that the 'null hypothesis' (H_0) can be assumed with no further analysis required.

Where ANOVA indicated significance the 'F value' was above 3 whereas it was closer to 1 where there was no significance – A high 'F value' suggests that the data does not support the null hypothesis.

The data shows that:

- LA absence statistics that do not focus on the method of collection and job role are of limited use and are not used to inform risk reduction strategies,
- services predominately comprising wheeled bins were associated with less absence than those with boxes baskets and bags,
- the service associated with least absence were when 2 operatives move 1100 L bins together,
- in every case where comparison was possible within individual LAs, there was higher MSD absence when boxes and baskets were included in the service.

4 Discussion

This study of waste collection systems confirmed extensive use of the use of sacks, boxes and baskets was associated with higher absence rates. Many LAs have failed to incorporate findings from published research (Pinder & Milnes 2002, Warburton, 2019) suggesting opportunity to reduce absence rates has been missed. Bagged collections remain a part of most wheeled bin collections to properties without facility for storage of wheeled bins.

Three of the LAs in this study used bags as the chosen method of collection with four others permitting side waste, possibly linked to the move to fortnightly collections, resulting in excess waste waiting to be collected. Recommendations by Oxley et al. (2006) that boxes should not exceed 40 litres were only found in 5 out of 16 collection systems. This appears to be the only criteria for acceptability with at least three authorities introducing glass collections in 40 litre boxes during 2013 and 2014 with food waste collections in 23 litre bins rolled out nationally after 2014.

The study suggests reducing repetitive movements associated with bending, twisting (Poulsen et al (1995) and throwing (Yang 2001), is best achieved through wheeled bin collections. For maximum risk reduction it is therefore best to exclusively use wheeled bins rather than in combination with boxes and sacks.

The method chosen successfully created a process to collect and compare similar ill health data indicating support with laboratory studies (Bomel 2004, Oxley et.al 2006, Jeong et al, 2016 and Ziaei et al 2018) allowing for comparisons to be made. Authorities did not have data readily available and had not considered the importance of comparing data between activities to enable management of work or organisational factors that could cause ill health absence and the introduction of interventions (McHugh 2001). In some cases, there was reluctance from HR practitioners to appreciate the value of a study that would identify the possibility of work-related factors contributing to MSD absence. This reluctance is a barrier to addressing such issues.

Discussions with one LA indicated that there was a greater need to use agency staff for boxed and basket collection when crews were short. This is also a compounding problem, with box/basket collections causing higher absence, this will lead to increased demand for agency staff. If consistent throughout the industry this would suggest that the method understates absence rates for boxed and basket collections.

Figures 7 and 8 suggest that staff who undertake a mixture of loading and driving have levels of MSD absence comparable with loaders who only handle wheeled bins. 'Loader-Drivers' have lower levels of MSD than those who only drive, supporting Kuijer (2002) who suggested that those who only drive attract high levels of MSD due to being exposed to body vibration and sit in a static posture. 'Loader-drivers' who handle 1100 L bins have the lowest level of MSD absence.

The use of general absence data through traditional methods masks the effects of collection systems is not sensitive to variation and differences in work. When broken down into MSD/Back pain and other reasons it is possible to see effects of different collection services. Both Figures 6 and 7 suggest that by recording all data. Targeted MSD related absence data uncovers patterns consistent with previous lab-based research and thus allows for improved interventions to be made (Feuerstein et al 2003).

Results suggest that 'the law of diminishing returns' may apply when seeking to reduce ill health absence rates that are below either 10 days per employee for all absence or 5 days

per employee for MSD absence as this in unlikely to be sustainable. This could be that absence rates have dropped to such a level that they are deemed acceptable and reflect an effect of diminishing improvement arising out of absence intervention. This means there can also be effects of non-MSD long term, and/or non-work-related illness that can have a disproportionate effect on absence rates.

Three authorities surveyed set organisational absence targets of below 8.0 days per employee, including office-based staff, where lower levels can be expected. It is important to correctly identify and separately categorise MSD absences such as 'operations' and 'Road Traffic Collisions' as any bias by incorrect categorisation will have greater effects where there are lower absence rates. The study of the return to work process identified a high percentage of MSD absences without identification as to the part of the body making identification of work factors very difficult to establish. To undertake appropriate analysis and interventions it's important to identify the 'part of the body', preferably in a recording system with standardised terms.

Staff carrying out the 'least strenuous' activity still have 'residual' absence with Burton et al. (2006) suggesting that the complete prevention of back pain (and consequentially absence) is not possible. Additionally, the results indicated issues with regards MSD absence amongst refuse collection drivers indicating a lack of management around the understanding of static loading as suggested by McGill (1997). The value of work-related absence will depend on the activity being carried out and the flexibility of the organisation in supporting staff including job rotation (Kuijer 2002).

It is suggested that the model proposed by Westgaard & Winkel (1997) is in effect far more complex taking on board confounding factors together with possible effects of age and multi-aetiological causation of back pain - with non-work fraction split into two separate fractions one being "natural ageing factors" and the other being non-work physical exercise. It must be remembered that the non-work-related fraction relating to natural changes can increase over several years, which can make any intervention less effective. With the main aim of ill health management in the workplace a vital

consideration is to identify work that gives maximum employability to those with MSDs irrespective of the cause.

With many LAs either reluctant to contribute to this survey, the time it took to obtain relevant data and that there has been no previous study, suggests that there is insufficient analysis of sickness absences with a view to improving work conditions (HSE 2015) noting that MSD (like ill-health in general) is difficult and more expensive to manage, compared to safety. Processes available to local authorities (Read 2013, Lamb 2013& Anastasi 2013) without hard data are of limited value without more complex and effective evaluations (Parry 2008). This may be due to a lack of understanding what data to collect, how to analyse it and how to effect change all of which is presented in this paper.

The study supports an organisational approach to MSD ill health (Kuijer et. al. 2007) rather than focus on individuals. Employees should be involved in the process, with exposure to risk factors minimised (Burton et al 2006) to improve their quality of life (Garrido et. al.2015).

The study suggests that it is possible to increase recycling rates and simultaneously reduce ill health rates. However, with an ageing workforce there are challenges minimising ill health arising out of work. Workplace rehabilitation for those who have been out of work and receiving benefits (Black and Frost 2011) and compliance with equalities legislation (UKG 2010) are both challenges with operations managers under pressure to maximise efficiencies with an older workforce relying upon ‘capabilities’.

In effect, organisations need to have two key strategies, one that has a system that manages a reduction of absence rates and that includes more ergonomically designed duties to make work more accommodating to all.

5 Limitations

The study identified 26 different combinations of collection systems and assumed that was no significant operational difference between similar systems when carried out in different LAs.

Although this is the first study to compare absence figures it does not consider confounding factors such as age, local geography or length of service. These confounding factors were assumed to be constant throughout the wider sample population. Other studies should therefore seek to strengthen any statistical relationships identified in this study.

The study identified that agency workers absence was not held by local authorities and anecdotally, where boxed collections were carried out, tended to do this activity rather than wheeled bin collection. This infers that the absence rates for those carrying out boxed collections maybe understated suggesting the findings could be on the conservative side. Additionally, absence of under 7 working days is self-diagnosed with no requirement to visit a medical practitioner.

Due to the interpretation of UK data protection law and a willingness to share information many local authorities approached declined to participate. Part of this reluctance may also be down to political influence and a fear of being o a league table.

6 Conclusions and Recommendations

The aim of this study was to ‘find the waste collection system associated with the least operative MSD absence using HR absence data’.

The study found that there was a reluctance for organisations to release data for an industry wide study and suggests that this issue may be perceived to be “too difficult to do”. There were statistical differences between different collection systems and MSD absence which were missing when comparing non-MSD absence. This shows how targeting specific types of absence is more informative than using blanket rates”. These ‘blanket absence rates’ drive absence management strategies that target individuals and mask the actual risk factors associated with different working methods.

In order to promote maximum fast recovery, it is important to remove the employee from the activity that is considered the cause of the problem (McGill 1997). Some LAs still retained a broader portfolio of council services in house, allowing for a full range of 'lighter duties' to be available. With outsourcing of some servicing some LA's may find it difficult to redeploy or rotate staff into light duties (i.e. redeploy staff to make reasonable adjustments) as the range of jobs will not exist.

With the data from multiple cases (LAs) this increases the certainty that the assumptions are correct.

Recommendations:

(i) To implement an industry wide classification system, such as parts of the body affected.; this could extend to a mapping exercise to identify type of absence to most probable cause based on worker's job.

(ii) That employers better interrogate absence data available in order to seek improvements in systems of work as suggested in this study.

(iii) Employers should have access to agency ill health data to improve the understanding of ill health effects on work.

(iv) Future research investigating absence in the UK should recognise the influence work has on absence, noting that there are many traditional jobs in the public sector which are physically demanding hence absence rates may be disproportionately high in that sector,

(v) As clients, LAs should specify methods of collection that minimise manual handling including:

- collection using wheeled bins or 1100 L communal bins rather than bags boxes and baskets (of any size).
- the development of new technologies within materials reclamation facilities to enable co-mingled recycling services to be developed.
- having waste collection policies that prohibit residual (side) waste in sacks

(vi) LAs, with a range of occupations, should create maximum flexibility for different work to allow for maximum opportunity for re-deployment on ill health grounds to posts requiring lesser physical activity (this also has

implications for contracted services when higher risk activities are outsourced with minimum opportunity for flexibility) in effect eliminating partial outsourcing.

This study adds to an ever-growing body of evidence for a compelling argument to change current industry practices. Employers, Trades Unions and Insurance Companies will all have interest in the dynamics of such an argument.

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Table 1 Summary of Statistical Analysis

Figure	Analysis	Test of Normality	Statistically Significant	ANOVA	Statistical Significance Test	Value (Where Stat.Sig.)	Comparison between activities:	
	1 The comparison of pooled absence rates – days off/employee							
2	All absence	Kolmogorov Smirnov	0/2	**0.034 (Significant)**	Tamahane	0.029	Wheeled Bins	Wheeled Bins with boxes
		Shapiro Wilk	0/3		Dunnett T3	0.029	Wheeled Bins	Wheeled Bins with boxes
					Games Howell	0.026	Wheeled Bins	Wheeled Bins with boxes
3	Loaders, all	Kolmogorov Smirnov	0/2	**0.037 (Significant)**	Games Howell	0.050	Wheeled Bins	Wheeled Bins with boxes
		Shapiro Wilk	0/2					
4	Drivers	Kolmogorov Smirnov	0/2	0.222 (Not Significant)				
		Shapiro Wilk	0/4					
	2 The comparison of absence with collection systems due to type of ill health - days off/employee							
5	MSD/back pain all employees between predominant service composition	Kolmogorov Smirnov	0/2	**0.046 (Significant)**	Tamahane	0.010	Wheeled Bins	Wheeled Bins with boxes
		Shapiro Wilk	1/3		Dunnett T3	0.010	Wheeled Bins	Wheeled Bins with boxes
					Howell	0.009	Wheeled Bins	Wheeled Bins with boxes
6	Non-MSD backpain all employee between predominant service)	Kolmogorov Smirnov	0/2	0.217 (Not significant)				
		Shapiro Wilk	0/3					

	3 Comparison of absence with employee role due to types of ill health – days off/employee							
	Comparison absence rates for all absence (all employees) and type of service	*Kolmogorov Smirnov*	*1/6*	*0.110 (Not Significant)*				
		Shapiro Wilk	*0/7*					
7	Comparison between absence rates for MSD/back pain (all employees) and type of service	Kolmogorov Smirnov	2/6	**Note 1[1] 0.008 (Significant)**	Mann Witney Note 2	0.002	Driver/Driver Loader	Loaders (Boxes and Baskets)[2]
		Shapiro Wilk	5/7					
	Comparison between days off/employee for non-MSD/backpain (all employees) and type of service	*Kolmogorov Smirnov*	*1/6*	*0.208 (Not significant)*				
		Shapiro Wilk	*1/7*					
	4 Comparison of absence with employee role due to types of ill health (Loader Activity Only) – days off/employee							
8	Comparison between days off per employee for all absence (all employees) and type of service (excluding drivers only).	Kolmogorov Smirnov	1/4	0.358 (Not significant)				
		Shapiro Wilk	0/5					
9	Comparison between absence rates due to backs and MSD's and type of service (excluding drivers only)	Kolmogorov Smirnov	2/4	Note 1 0.060 (Not Significant)				
		Shapiro Wilk	3/5					
10	Comparison between days off per employee for absence (excluding- Backs and MSD's) and type of service (excluding drivers only).		1/4	0.201 (Not significant)				
			1/5					

[1] Note 1- Independent Samples Kruskal Wallace Test ;

[2] Note 2 – Bonferroni Adjustment, k, =0.003

Summary Methodology

Step 1- Identification of Authorities

Identify UK Local Authorities that have in-house Waste Collection Services (180 LAs)
Identify contacts in each UK region through industry meetings (63 LAs)
Identify different methods of waste collection

Step 2 – Data Collection

Send out information pack with proforma to 63 LAs
Carry out follow up contacts
Obtain information from 15 LAs for each financial year where data available
Follow up where cases of incomplete data
Collate data using Microsoft Excel and transpose into SPSS

Step 3 Data Analysis

Aim is to compare absence rates for MSds with non MSds for each primary job/role

Comparison of absence rates by authority identifying service type -comparing 'total' with primary 'job/role' Group Data	Comparison of absence rates by authority identifying service type – comparing 'total' with 'MSDs' and 'non MSDs' Group Data	Comparison of absence rates for each authority and job role comparing 'total' with 'MSDs' and 'non MSDs' Individual Data

Stage 4 Statistical Analysis

SPSS – Use of Box Plots identifying days off/employee and showing: • Median • 75th and 25th Percentile • Upper and Lower Bound • Outliers	SPSS – Tabular comparison of days off/employee showing: • Mean • Number of entries • Standard Deviation
ANOVA – Tests for significance (>0.05) Test for Normality (Kolmogorov- Smirnov / Shapiro- Wilk) Where required: 1. Independent Samples :Kruskal- Wallis Test; Mann Witney post-hoc test with Bonferroni Adjustment) 2. Tamahane post-hoc test and Dunnett T3 post-hoc test	