DISCUSSION

This study fills a number of gaps between other studies. The symptom questionnaires give an up-to-date picture of the subjective symptoms of all parts of the body reported by cashiers in three B.C. stores in 1996. The subjective comments from the questionnaires correspond closely with findings of the postural assessment. Recommendations made by workers on the questionnaires agree in many cases with recommendations made in other studies (Wells, et al., 1990; Baron et al., 1991; Kennedy, et al., 1992, Ergo Systems Inc., 1992 and FMI, 1992). The postural assessment in this study differs from others in a number of aspects. Instead of focusing only on the major checking tasks, such as scanning, bagging or keying, the assessment includes the full set of tasks performed by the cashier for the entire length of time checking a cart of groceries excluding bill payment. Reports of the percentages of time for each postural angle, therefore, reflect the percentage of true working time, rather than the percentage of time for the specific task.

This study is also unique because it compares postural angles using the same three workers at four checkstand types. Most studies conducted have not used the same subjects (Wells, et al., 1990; Marras et al., 1992; Ergo Systems Inc., 1992), confounding the comparisons between checkstand types with differences in individuals' technique or size. This study looks for differences in posture between different heights of workers. The three workers represent the 5th, 50th and 95th percentile of heights for females. Although definitive statements can't be made linking checkstand design to the different heights of workers based on only one subject at each height, this comparison does allow for observations about how the relationship between checkstand style and technique vary for different worker heights. The Vision 3000 motion postural analysis system allows specific tasks such as bagging, keying, and scanning to be observed. This gives good insights into differences in technique and adaptations workers make, given the relationship between their height and the checkstand configuration.

This is the only study known to analyze the percentage of time spent grasping grocery items. Since activity-related soft tissue disorders result from a combination of high repetitions, awkward postures, and forceful exertions, the percentage of time grasping can help give indications about the amount of time spent in forceful exertions.

Distribution of the questionnaire survey was well organized by Safeway, which is reflected in the 87% response rate. Workers at the three stores surveyed fit into a general description of being fairly young (average age of 31 years), experienced (average of nine years), and classified as part time (75%), although working hours (average of 31.5 per week) were closer to those of full-time employees. Three-quarters of respondents report significant pain or discomfort in the past month. A similar question in the Ontario study found 91% of respondents reported significant pain in the past 12 months (Wells et al., 1990). This study shows that 64% sought medical attention for the problem, compared with 47% in an earlier study in B.C. by Stoffman (Stoffman, 1983). In Stoffman's study, time loss affected 30% of cashiers, compared with 64% who sought medical aid in this study, but only 18% who reported WCB claims.

Parts of the body where significant pain or discomfort had occurred in the past month is similar for the cashiers in this study as in other studies, despite differences in the question and the length of time for recall (Kennedy, 1992; Stoffman, 1983; Wells et al., 1990; Baron, 1991). Back pain is most common, with 67% of cashiers in this study reporting significant pain in the past month. This is similar to 70% reported in the Ontario study, but higher than 57% found by Kennedy et al. (1992), 45% by Baron (1991) and 33% found by Stoffman (1983). Shoulder pain is the next most frequent, reported by 55% of cashiers in this study. This is similar to findings by Kennedy in B.C. of 52%-59%, and slightly higher than Wells (45%) and Stoffman (17.5%) findings. Wrist pain is reported by 41% of cashiers in this study, much higher than the 12 month report of 20% of the Ontario cashiers and 6%-7.7% in Stoffman's study. However, hand pain in this study (7%) is much lower than that reported by Wells (38%), Baron (29%), Kennedy (20%-26%), and Stoffman (9%-11%). Neck pain in this study (35%) is less than findings by Wells (46%) and Kennedy (42%), but greater than that from Baron (16%).

The questionnaire in this study was designed to report the levels of pain and discomfort at three Safeway stores where there were high injury rates. It was not designed to detect differences in pain and discomfort between different checkstand types. Kennedy's study (1992), on the other hand, was designed for the purpose of detecting differences between checkstand types, and, as such, stores were chosen where workers checked exclusively on one full-length checkstand and one type of express checkstand. Kennedy (1992) found that the tribelt checkstand was associated with higher rates of abnormalities, and that bilateral problems were more common at these checkstands.

Almost all respondents to our questionnaire use the tribelt checkstand, usually in combination with one or two other types. Therefore, it is extremely difficult to differentiate pain or discomfort between the four checkstand types. When injured, a cashier often cannot associate that injury with a particular checkstand. Despite these issues, our results do suggest that those workers who check at a combination of the tribelt and counter express, report more pain than those who use the tribelt, counter, and rotary checkstands. The addition of the rotary checkstand was beneficial in reducing the pain and discomfort. The workers in this study using the tribelt and tribelt combinations, compared with those using the rotary and rotary combinations, are more likely to have pain. Another interesting finding, however, is that, those workers at the tribelt and its combinations are also less likely to take regular breaks every two hours. At the tribelt, and tribelt combinations, 80% of cashiers work at least half their time without breaks every two hours, compared with 49% doing the same at the rotary combinations. It is difficult to know from this whether the checkstand design, or the lack of breaks is contributing to the pain.

In Kennedy's (1992) study, she reported time-related factors, such as the number of years scanning, full-time work, and high volume days, as being the most important in predicting hand and wrist problems. Working with insufficient breaks is also a time-related or "repetition" factor. Repetition becomes a risk factor for ASTDs when there is

insufficient recovery from the exertion. Working with missed or late breaks prevents recovery. In the subjective comments of the questionnaire, workers suggest more service clerks, more consistent and frequent breaks, rotation of tasks, and better shift scheduling. All of these suggestions point to the need for a reduction in the amount of repetition to provide more opportunity for recovery from the checking tasks.

No significant relationship is found between the percentage of time a cashier reports having a bagger and symptoms of pain or discomfort. Almost one-third of cashiers report having a bagger less than one-quarter of the time. On the subjective comments, however, many cashiers suggest having wrappers all the time would reduce injury. They state that bagging is stressful, involving considerable reaching, twisting, lifting, and one-sided work. Many workers dislike the system for opening bags onto the brackets. Cashiers suggest that bagwells need to be height adjustable, firmly attached to the checkstand, and closer to the cashier to provide a shorter reach. Many cashiers also suggest using bigger and stronger bags.

The postural analysis yields some very interesting observations. The combination of the gross postural analysis of all parts of the body, over the full duration of scanning, keying, and bagging, gives a good comparison of the posture of various parts of the body for the full task of checking groceries. The more detailed Vision 3000 computer analysis of the discrete tasks including bagging, scanning two items, and keying, allows for identification of the tasks which likely contribute most to the various postural angle averages. It also shows the differences in technique and subtleties in checkstand design that result in postural adaptations.

As mentioned earlier, it's difficult to compare this postural analysis with that of other researchers. There are a number of reasons for this: different checkstand types were analyzed in each study; definitions of "neutral" and "non-neutral" postural angles differ widely between researchers; and most analyzed portions of the job, such as scanning, did not include all tasks together. Therefore, note any differences with caution. In general, for the entire job of checking groceries, the most frequent awkward postures include neck flexion, followed by trunk twisting, and left shoulder extension. The proportion of time for each depends upon the height of the cashier and the type of checkstand. In this study, long periods of neck flexion are more frequent than reported in other studies (average of 59% of time in greater than 30° across all checkstand types and workers, compared with 10% of time in study by Marras, et al., 1992). Trunk twisting is also more common in this study (average of 23% of time) compared with others who reported it (10% of time in Wells et al., 1990). Both of these postural angles are linked with bagging practices, which were often not analyzed in other studies. Left shoulder extension, in this study, averages 17%, compared with 50%, in the U.S. study (Marras et al., 1992). The 50% left shoulder extension might be explained by the different types of checkstand configurations analyzed in the U.S. study.

The postural angles, including right shoulder extension, right and left shoulder flexion, right and left wrist flexion, right and left wrist extension, and left ulnar deviation, were all close in proportion of time when averaged across the four checkstand types and three workers (from 7% to 10% of time). There are differences depending upon the worker and checkstand; however, on average, the percentages are lower than those reported by other researchers (Wells et al., 1990 and Marras et al., 1992). Again, this is likely because the other studies only looked at the scanning process. The Vision 3000 analysis of scanning two items shows much higher proportions of time in wrist flexion, extension, and ulnar deviation. This is more consistent with other studies.

The tall worker consistently experiences higher proportions of time with her neck flexed 30° or more; at the counter express and tribelt, she spent 100% of the total checking time in this posture. Since she has very little back flexion, the tall worker must have chosen a technique to keep her back upright. This compromised her neck posture. Neck flexion is considerably less for workers at the tribelt compared with the other checkstands. This is because, at the tribelt, workers look forward to preplan the selection of items and cashiers tend to scan without looking downwards. With the scanner window located directly in front of them, looking downwards is likely often not necessary. The neck flexion at the other checkstands, therefore, relates to bagging, not to scanning. To bag, cashiers need to continually look downwards to ensure careful placement of items into the bag, and this is even more apparent for the tall worker.

The tall worker spends a high proportion of time with wrist extension exceeding 45°. This occurs for both hands during the scanning process and is evident in the left hand when placing items into the bags. Again, to compensate for her height, the tall cashier extends her wrist when lowering items into the bag, rather than bending her back. The right wrist of the tall worker also spends high proportions of time in extension during the task of keying. This is because the keyboard height is fixed and the inclination is excessive. Greater ulnar deviation is found in the left wrist of the tall worker. This, too, is associated with lowering items into the bag and swinging the bag of groceries onto the counter. The tall worker has greater back flexion during the bagging task at the rotary checkstand where bags are lowered into the customers carts. The tall worker experiences the least amount of time with both wrists in a neutral posture during scanning compared with the other two workers. This relates to right wrist extension when grasping and scanning an item, and left wrist extension and ulnar deviation when bagging items and lifting bags.

The posture for the short worker is quite different. The short worker experiences a higher proportion of time with both right and left shoulder in flexion. This relates to reaching for items with the right arm, in some cases, reaching to the keyboard when keying, and at the express checkstands, to lifting the bags of groceries onto the counter surface. The short worker also experiences a higher proportion of time in right wrist flexion compared with the other two workers. When grasping the top of an item in preparation for scanning, the short worker's wrist is in flexion (combined with grasping), while the tall worker's wrist is in extension. The short worker also experiences wrist flexion when

keying because the height of the keyboard is not adjustable downwards. Two studies have reported a higher incidence of wrist injury in workers of shorter stature (Kennedy, 1992 and Baron, 1991). Grasping while the wrist is in flexion is a higher risk for hand-arm disorders than when grasping in neutral or wrist extension. The fact that the shorter worker experiences more wrist flexion associated with grasping items, could explain their higher incidence of wrist injuries.

The percentage of time workers are grasping an item ranges from 46% to 77%. There are no distinct trends either with cashier height or checkstand type. When a cashier is not grasping an item, she is moving between items and reaching for the next one, or she is keying. Since the combination of awkward posture and forceful gripping is important in the development of hand-arm disorders, the less time spent gripping items, especially in awkward postures, the less risk of injury.

Some differences in posture between checkstand types are apparent. At the tribelt checkstand, there is less neck flexion for all but the tall worker. This is likely because, as mentioned, workers gaze forward and do not need to look downwards to scan items. With the scanner window located squarely in front of the cashier, this reduces the need to look down to find the scanner to swipe items. There is also less shoulder abduction at the tribelt. This is likely because items are moved in a forward-backward plane, eliminating the need for sideways reaches. Less ulnar deviation was found at the tribelt. This is understandable as ulnar deviation is most related to bagging, which did not take place at the tribelt. On the problematic side, there is considerable twisting of the back at the tribelt. This is related to passing groceries behind the body onto the conveyor. Shoulder extension of both arms is also very apparent. Since there is no bagging at the tribelt, all the shoulder extension is associated with the scanning task. Workers spend, on average, half their time in shoulder extension at the tribelt (75% for the short worker). There are also more severe degrees of shoulder extension measured by the Vision 3000 system at the tribelt.

At the counter express, all workers experience more back flexion and a higher proportion of time in shoulder flexion compared with the other checkstands. This is likely associated with the reaching forward and sideways for groceries since there is no belt to bring items closer. During bagging, there is more left shoulder extension at the counter express. This is related to the angled-design of the counter area behind and to the left of the cashier. At the belt express, the bagwell is flush with the counter. Therefore, cashiers experience less shoulder extension to swing the bag up onto the counter. There is more right wrist flexion in the 0°-30° range at the counter express. This likely relates to the reaching and grasping of items. Both the counter and the belt express have the highest proportions of time in left wrist flexion.

Compared with others, the rotary checkstand produces the lowest proportions of time that cashiers spend in non-neutral postures of the body with one exception: shoulder extension of the left arm is highest at the rotary checkstand. This is largely due to the practice of lifting the bags with the left arm and twisting the back and shoulders to place

the bag into the customer's cart. Twisting and shoulder extension at this checkstand are the major postural problems. They mostly relate to placing bags into the cart. Other studies that have compared various checkstand designs have also favored the rotary (also called front) design (Marras et al., 1992, Wells et al., 1990, Ergo Systems Inc., 1992 and Grant, 1993). While there are still problems with the rotary checkstand, there are fewer non-neutral postures and fewer symptoms associated with its use (Kennedy et al., 1992).

When looking specifically at the various tasks, the process of bagging, either at the express or regular checkstand, is associated with more non-neutral postures than either scanning or keying. Bagging, as mentioned, produces high proportions of time in neck flexion for all workers. Bagging also results in considerable twisting since the left hand is inside the bag releasing an item at the same time that the right arm is reaching for the next item. Left shoulder extension and back twisting are related to swinging the bag behind the back to place it into the customer's cart. Shoulder flexion, especially for the smaller workers, is related to lifting the bags onto the counter at the express tills. Wrist extension and ulnar deviation for the left hand are largely due to placing items into the bag.

There are definite differences in bagging techniques between workers. The medium-height worker places both handles in her left hand and swings the bag up onto the counter at the express checkstands. This results in considerable shoulder extension and back twisting. In Kennedy's study (1992), this one-handed practice of lifting was found to be associated with low back problems. The short worker uses a preferable technique: she lifts the handles off the rack, then steps backwards with the bag held close to her body. This minimizes shoulder extension. She then uses two hands to lift the bag up onto the counter. She still experiences substantial shoulder flexion, but less back twisting. At the rotary checkstand, some workers pull the cart close to the end of the checkstand and turn to their left to place the items into the cart. This results in extremes of left shoulder extension and twisting of the back. One worker leaves the cart quite close to the cash register, and instead, turns to her right, placing the bag in the cart with both hands. She turns her feet, which minimizes back twisting and shoulder extension.

Several other researchers have recognized the practice of scan-and-bag as high risk for postural problems (Wells, et al., 1992, Ergo Systems Inc. 1992, Stoffman, 1983). Other studies suggest more bagging and wrapping clerks, or rotating cashiers from scanning to bagging for a change in work. Many of the postural stresses that this report associates with bagging would be reduced if cashiering did not combine bagging with reaching and scanning. Height adjustable bagwells would further reduce problems. In the questionnaire, approximately one-third of the cashiers surveyed report having a bagger only up to one-quarter of the time. On subjective comments, many mention the need for baggers or job rotation. Other studies suggest a rotation scheme where a worker scans for one hour, then bags for 45 minutes, then has a 15 minute break (Wells et al., 1992, Ergo Systems Inc., 1993). Some researchers suggest a maximum of 4.5 hours/day (Ergo Systems Inc., 1993).

Although fewer postural problems are found with the rotary checkstand, all four checkstands fall short of recommended guidelines for checkstand dimensions and design. None of the checkstands are height adjustable. This has a major impact on the posture of the shorter and taller workers. All of the checkstands are too low, especially the express checkstands. The keyboard height is also not adjustable at any checkstands. This directly affects shoulder flexion and wrist posture. The reach to the keyboard and the inclination on the keyboard stand are also excessive. The reach to the scanner is further than recommended at all checkstands, except the tribelt. Excessive reaches are the single highest problem identified on the questionnaire by cashiers. The bagwells at some checkstands are height adjustable, although, cashiers often do not adjust them, and work with them at heights that are too high. This results in excessive shoulder flexion at the express checkstands as the cashier must lift the bag up and over the bagwell. None of the read-outs are placed in front of the cashiers, nor are they adjustable. Although neck twisting was not measured, the location of the displays necessitates considerable neck and back twisting to view them. There is also insufficient toe space at all checkstands to allow the cashiers to stand close to the checkstand. This further extends reaches.

All of the recommended design features exist in checkstands currently operating in B.C. stores. Adjustable height checkstands are available, as are platforms that can readily slide into place to vary the height for an individual. Adjustable keyboard holders with angle variations, and height adjustable bagwells are readily available. Several stores have placed the scanner within an appropriate reach, and placed the electronic eye and conveyor close to the cashier. Placement of the digital readout in front of the cashier, or dual read-outs are also options in many stores. In-house maintenance personnel have increased toe space. Workers suggest footrests, more knee space, better mats, and sit-stand stools on the questionnaire. These devices have also been built into some checkstand designs in other stores.

On the questionnaire, many workers report problems with the scanner and UPC codes. Although the study did not look specifically at the scanner technology, workers commented that the scanners need improving so they can scan faster. Some workers suggest tear away tags, and improved UPC codes. Ideally, the UPC code should be located on the natural bottom of items, especially heavy items, such as milk and two litre bottles of pop. Currently, orienting these items for a scan on the side involves bending the wrist, even with the best technique. Working with manufacturers to standardize and properly locate UPC codes is suggested. Some studies find that vertical scanners (horizontal beam) work more efficiently and result in less wrist deviation for the worker (Marras et al., 1992). With vertical scanners, the UPC code needs to be placed on the side of items. If most items have the UPC code on the side, vertical scanners may be a better option. The combination of horizontal and vertical scanners to accommodate both UPC code locations would likely dramatically reduce the awkward wrist postures involved in scanning.

Handling heavy items is mentioned as a problem by cashiers on the survey and is recognized as a problem in other studies (Wells et al., 1992, FMI, 1992). Cashiers state that there is insufficient space for heavy items which results in considerable lifting. Tear away tags, or pen readers, or some system which encourages customers to leave heavy items in the cart would help reduce the stresses in this task.

A large number of cashiers recommend the need for more training and education, especially for new hires. Specific technique training is not done systematically in Safeway stores. Organization of breaks is also a problem, and, as seen in the statistical analysis, is related to symptoms of pain and discomfort. Cashiers suggest giving thought to better administration of workers, including scheduling, rotation, breaks, and numbers of cashiers.

CONCLUSIONS

1. Over a five-year period at Safeway there were 350 repetitive strain injuries (RSIs) and 1,164 back strains, with an average days lost per claim of 145 and 40, respectively. The average RSI claims' duration for cashiers at Safeway is 30% longer than others in the retail subclass. The total direct cost for RSI claims at Safeway over a five-year period is $3.8 million. Back strains at Safeway cost almost $5.6 million over the same five year period and the average cost per back claim is over 60% higher than the average for the subclass. Therefore, musculoskeletal injuries alone cost Safeway $9.4 million over a five year period--almost $2 million per year. Longer claims' duration and costs compared with others in the subclass may be due to one or a combination of: claims and return-to-work policies or practices; average wages at Safeway; or the severity of injuries.

2. There are fewer cashier injuries at the Richmond store (#35), and considerably lower numbers of days lost compared with the Surrey (#62) and Langley (#59) stores. It would be interesting to determine if different management of claims and return-to-work practices are operating at these locations. Almost three-quarters of the strain injuries occur to cashiers between 19 and 30 years of age; however, the distribution of cashiers by age in the stores is not known. According to Safeway statistics, younger workers make up a larger percentage of the injuries, but a smaller percentage of the days lost compared with older workers. The highest percentage of injuries occurs to the arm, hand, and finger (39%-45%), followed by the back (32%-40%), and shoulder (18%-32%).

3. Based on questionnaire responses from 161 cashiers at three stores, the average cashier at Safeway is 31 years old, has worked as a cashier nine years, is classified as part-time, but works an average of 31.5 hours per week.

4. More than three-quarters of cashiers responding to the questionnaire report significant pain or discomfort in the past month. Cashiers report working an average of 2.75 years with this pain or discomfort. Approximately 18% missed work in the previous six months due to a WCB claim. Pain is most commonly reported in the back (67%), shoulder (55%), wrist (41%), neck (35%), leg (35%), and arm (29%).

5. Since most cashiers use more than one checkstand type, it is impossible to distinguish the differences in cashier pain and discomfort due to a particular checkstand design. However, those workers using the tribelt, counter express, and rotary checkstands report significantly less pain than those using the tribelt and counter express checkstands. This suggests that use of the rotary checkstand might be beneficial in preventing pain in some cashiers.

6. More than half of respondents indicate that at least 75% of the time they work two or more hours without a break. It is significantly less likely that cashiers using the tribelt take regular breaks. It is, therefore, difficult to determine whether the greater pain resulting from more frequent use of the tribelt is due to the checkstand design, or lack of regular breaks.

7. Although 94% of cashiers report having a bagger, almost one-third report having a bagger less than 25% of the time. There is no relationship between having a bagger and reports of pain.

8. On subjective comments, cashiers most dislike excessive reaching and inappropriate working heights. This is most often related to groceries not coming close enough, and checkstands, bagwells, and keyboards that are not height adjustable. Cashiers want wrappers, improved bags, relocation of the electronic funds transfer pad, sit-stand stools, improved footrests, and more knee space. Cashiers also suggest more training, improved staffing levels, job rotation, better breaks, and a limit to the number of hours and consecutive working days on express tills.

9. None of the checkstands have measurements consistent with recommended guidelines in the literature. Checkstand height is too low and not adjustable; the scanners are too far away; keyboards are too far to reach, inclined too much, and not height adjustable; bag racks are too high and not all are height adjustable; toe space is insufficient; and the digital readout is too far to the side.

10. Results from the postural analysis show the most frequent awkward postures to be neck flexion, trunk twisting or sideways bending, and shoulder extension of the left arm. Percentages of time in these awkward postures vary greatly depending upon checkstand type and height of the worker. Neck flexion and trunk twisting are considerably higher than percentages reported in other studies. Both are related to scan-and-bag practices, lifting bags of groceries, and turning to place them in a buggy. Bagging practices are not often analyzed in other studies.

11. The tall worker spends a high proportion of time in excessive neck flexion (greater than 30°), but has very little back flexion given her relationship to checkstand height. She tends to bend her neck instead of her back. The tall worker spends more time with her wrists in non-neutral postures compared with other workers. She experiences wrist extension in both hands when scanning, in the left hand when lowering items into the bag, and in the right hand when keying. She also experiences more left ulnar deviation when placing items into the bags.

12. The short worker experiences a high percentage of time with both right and left arms in shoulder flexion. This occurs when reaching for groceries, when keying and when lifting bags onto the checkstand counter at the express tills. She also experiences more time in wrist flexion. This occurs when grasping items (due to the relationship between her height and checkstand height), and when keying. Two studies have found a higher incidence of wrist problems with shorter cashiers. The combination of grasping and wrist flexion may relate to this.

13. Cashiers spend from 46% to 77% of their working time grasping. There are no consistent differences in the percentage of time between different checkstand types or height of workers.

14. The tribelt checkstand is associated with less neck flexion, shoulder abduction (movement of the arm to the side), and ulnar deviation (wrist bending toward the baby finger), compared with other checkstand types. Cashiers tend to look forward to pre-sort items, and, because of the location and orientation of the scanner, (i.e., close, and in front of them), do not look downwards. Since there is no bagging, they don't need to focus on carefully placing items. The tribelt, however, is associated with considerable trunk twisting and extreme degrees of shoulder extension when passing groceries behind the body.

15. The counter express checkstand is associated with more back, shoulder, and right wrist flexion than other checkstands. This is likely due to the absence of a belt to bring groceries closer causing considerable right arm reaches. There is also greater left shoulder extension at the counter express, likely due to the angled design of the rear counter. Cashiers need to extend their left shoulder backwards when lifting the bags up onto the counter surface.

16. The most time spent in neutral postures was observed at the rotary checkstand. Other studies also have found the rotary design to be preferable for posture and fewer reported symptoms. The major problems with the rotary checkstand are left shoulder extension and twisting of the trunk. Both of these postural problems are related to lifting bags and turning to place them in grocery buggies.

17. Bagging is associated with more non-neutral postures than other tasks. It contributes to more neck flexion because careful placement of items involves downward vision. Bagging causes more twisting, left shoulder extension, and left ulnar deviation when placing items into the bag while simultaneously reaching with the right arm. The short worker experiences shoulder flexion when lifting bags onto the counter and the tall worker experiences back flexion when lowering bags into the carts. All workers experience considerable twisting and left arm extension when turning to place bags into buggies. The literature recognizes that scan-and-bag techniques are problematic. Reducing many of the postural stresses is possible if wrappers are consistently made available, or cashiers scan all items prior to bagging.

18. Considerable differences in technique are observed between various workers, especially in the bagging task. Musculoskeletal loads can be reduced by identifying, training, and promoting good techniques.

19. Most of the suggestions for physical modifications to checkstands that workers made on the survey already currently exist in checkstand designs in B.C. It is important that Safeway make checkstands appropriate for all heights of workers, and allow variations in posture according to preference and individual techniques. Implementing the recommendations in the next section, would dramatically reduce awkward postures measured in this study, and would increase worker satisfaction, based on responses from the questionnaire survey.

20. In the survey, cashiers suggest improved organization of cashiering work. Examples include improving the frequency and consistency of breaks, implementing job rotation, limiting hours and number of consecutive days worked on certain checkstands, and improved training. Other researchers agree that the greatest potential for injury reduction involves a combination of physical workstation modifications and organizational changes.

RECOMMENDATIONS

1. Discontinue the practice of scan-and-bag and provide wrappers to cashiers as a regular practice. Alternatively, organize work such that cashiers can scan all items prior to bagging. It is preferable to perform bagging off the back end of the checkstand.

   Eliminate the practice of scan-and-bag to reduce awkward postures including: neck flexion to view the bagging; back twisting and right arm reaching to simultaneously grasp with the right hand and release items into the bag with the left hand; left shoulder extension and back twisting when placing full bags into the buggies; shoulder flexion at the express checkstands when lifting bags onto the counter surface; and left wrist extension and ulnar deviation when lowering items into the bags.

2. Schedule workers so the tasks of scanning and wrapping can be rotated between workers. One suggestion made in other studies is to scan for one hour, bag for 45 minutes, then proceed to a 15 minute break. However, any reduction in the time spent scanning groceries will reduce exposure for cashiers.

3. Physically modify checkstands so that they are appropriate for workers of all heights and allow variation in posture according to individual preference and technique. The following recommendations pertain to all checkstand types.

   3.1 Checkstand height should suit the worker. Accomplish this with adjustable checkstands (such as hydraulic mechanisms), or by providing fitted inserts to raise the flooring and worker, or by providing checkstands of different heights and assigning workers to the checkstand with the appropriate height for them. A range of 90 cm to 105 cm should be accommodated. A 15° slope toward the cashier would improve vision and reduce neck flexion.

   3.2 Adjust keyboard height to accommodate a range of 55% to 65% of the cashiers' height. Do not exceed a downward viewing angle (towards the keyboard) of greater than 35°. Adjust the keyboard in the fore and aft (closer to the cashier) positions. The maximum angle of the keyboard (including the tray) should be 15°.

   3.3 Provide adjustable sit-stand stools or posture bars to vary posture (55 cm-80 cm in height). Provide good quality padded mats, adjustable footrests with sufficient space for the feet (width of 45 cm, depth of 5 cm, and inclination of 15° -25°), and improved leg space.

   3.4 Adjust conveyors and diverter bars which help bring products closer to the cashier so the reach to items is minimal.

3.5 Locate the digital read-outs in front of the cashier (within 15°-35° of horizontal line of vision and 20° to either side).

3.6 Locate bagwells at the rear of the checkstand and make them height adjustable (33 cm to 43 cm below the checkstand).

3.7 Locate the electronic funds transfer in front of the customer to reduce reaching.

3.8 Place multiple scanners at various angles at new checkstands to reduce the bending of the wrist. Enlarge scanner windows. Evaluate vertical scanners for improved effectiveness and reductions in awkward posture.

3.9 Specific recommendations for each checkstand type include:

Tribelt: Move take-away belts forward to reduce the excessive shoulder extension, twisting, and lifting of groceries when passing them to the conveyors.

Counter Express: Discontinue this checkstand, or install conveyors to reduce reaching and bending. If a wrapper is not provided cut away the angled counter to make it flush with the bagwell. Reduce the counter height (for bags) to the level of the bottom of the bagwell to eliminate swinging and lifting grocery bags onto the counter top and make the bagwell height adjustable.

Belt Express: If a wrapper is not provided, reduce the counter height (for bags) to the level of the bottom of the bagwell and make the bagwell adjustable in height.

Rotary: If a wrapper is not provided, as a minimum, eliminate bagging into the cart to reduce twisting and shoulder extension. Provide rollers or a conveyor for bags to move to the end of the checkstand. Alternatively, provide a cut-out at the end of the checkstand for the cart.

4. Provide appropriate equipment and training for cashiers. Develop store policies for handling heavier items. For example, label all items exceeding 10 lbs. Train cashiers not to lift these items, but to key-in the codes manually and slide them onto the conveyor. Place rollers over the scale to facilitate pushing items. Tag items heavier than 25 lbs with removable UPCs, or encourage customers to leave them in the buggy. Provide pens or wands for scanning these items.

5. Train cashiers in good techniques to reduce the percentage of time cashiers spend grasping an item. Discourage cashiers from picking up each individual item. Include information on scanner technology; location and orientation of items for optimizing scanability; how to eliminate redundant handling of items; use of the power grasp rather than the pinch grip; how to minimize reaching by waiting for the items to come closer; how to minimize lifting prior to placing items in the

6. Implement and evaluate a variety of different work organization options. For example: rotating to different non-cashier jobs within the store; limiting hours worked per day; limiting number of consecutive days on the express checkstand; limiting express checkstand work to one hour; providing breaks more frequently than every two hours; and ensuring breaks are taken at scheduled times.

7. Investigate differences between stores to help explain the large differences in injury incidence and days lost per claim. Improve injury reporting and treatment, return-to-work, and accident investigations to reduce injury frequency and severity.

8. Over the long term, investigate and evaluate improved systems for opening and holding bags. Evaluate improved bags with features such as longer handles. Encourage manufacturers to provide standardized labeling of UPC codes on the natural bottom and side of items to make scanning easier for horizontal and vertical scanners.

REFERENCES

Barnhart, S., and Rosenstock, L. 1987 (July), Carpal Tunnel Syndrome in Grocery Checkers A Cluster of a Work-Related Illness, The Western Journal of Medicine, pp.: 37-40.

Baron, S., Milliron, M., Habes, D. and Fidler, A. 1991 (January). Shoprite Supermarkets, New Jersey-New York. Hazard Evaluations and Technical Assistance Branch, National Institute for Occupational Safety and Health (HETA 88-344-2092), (61 pages).

Carrasco, C., Coleman, N. Healey, S. and Lusted, M. 1995. Packing products for customers. An ergonomic evaluation of three supermarket checkouts. Applied Ergonomics, 26(2): 101-108.

CCOHS 1990, Ergonomic Infogram E-101, Cashier Workplace - Workstation Document No. 90/60190.

Ergo Systems Inc., 1992 (June). Taking a proactive approach towards incorporating ergonomics into current and new checkstand designs. Canada Safeway Ltd. (62 pages).

Food Marketing Institute, Loss Prevention Services Dept., 1992. Suggestions for Ergonomic Improvement of Scanning Checkstand Designs, Washington, D.C. (20 pages).

Grant, K.A., Habes, D.J., Baron, S.L., Sweeney, M.H., Piacitelli, L.A., Putz-Anderson, V. and Fine, L.J. 1993 (November). Ergonomic evaluation of checkstand designs in the retail food industry: A report based on expert assessment. Appl. Occup. Environ. Hyg., 8(11): 929-936.

Harber, P., Bloswick, D., Luo, J., Beck. J., Greer, D., Pena, L.F. 1993 (July). Work-related symptoms and checkstand configuration: An experimental study. Am. Ind. Hyg. Assoc. J., 54: 371-375.

International Business Machines Corporation, 1981 (November 1). Checkstand design for the scanning environment (document number GG24-1551-0). Raleigh System Centre. IBM. (46 pages).

Kassadisk 1983. Check-out Points - Islands for Two, Hagin, Goteberg, Sweden. (12 pages).

Kennedy, S.M., Hertzman, C., Brubaker, B., Stoffman, L., Van Netten, C. and Jin, A. 1992 (March 15). Prevalence of muscle-tendon and nerve compression disorders in the hand and wrist of a working population of grocery cashiers utilizing laser scanners. Occupational and Environmental Diseases Research Unit, University of British Columbia, Departments of Medicine and Health Care and Epidemiology, (33 pages).

Lannersten, L. and Harms-Ringdahl, K. 1990. Neck and shoulder muscle activity during work with different cash register systems. Ergonomics, 33(1): 49-65.

Marras, W.S., Lehman, K.R., Greenspan, G.J., Nelson, J.E., Lee, C.C., and Fathallah, F.A. 1993 (December). A Field Biodynamic Evaluation of Checkstands and Scanners FMI Ergonomics Task Force Phase III Final Report. Biodynamics Laboratory, The Ohio State University, Columbus, Ohio. The Food Marketing Institute. (119 pages).

Marras, W.S., Nelson, J.E., Davis, K.G., Fathallah, F.A., Allread, W.G., and Lee, C.C. 1994 (June). A Biomechanical Analysis of Two Grocery Checkstand/Scanning Operations: Phase II Continuation. Biodynamics Laboratory, The Ohio State University, Columbus, Ohio. (97 pages).

Marras, W.S., Marklin, R.W., Greenspan, G.J. and Lehman, K.R. 1995. Quantification of wrist motions during scanning. Human Factors, 37(2): 412-423.

Orgel, D.L., Milliron, M.J., and Frederick, L.J. 1992 (August). Musculoskeletal discomfort in grocery express checkstand workers. An ergonomic intervention study. JOM, 34(8): 815-818.

Ryan, G.A. 1989. The prevalence of musculo-skeletal symptoms in supermarket workers. Ergonomics, 32(4): 359-371.

Stoffman, L.D., Sterling, T.D., and Rourke, C., 1983 (June 30). An occupational health survey of clerks and cashiers in the B.C. retail food industry. Retail Clerks Union, Local 1518 (UFCW), (50 pages).

Stoffman, L.D., Wallersteiner, U., and Gordon, R. 1986 (March 15). Integrating ergonomics into the design of laser/scanner checkout systems (project file #84036). United Food and Commercial Workers Union, Local 1518 (49 pages).

Strasser, H. 1990. Evaluation of a supermarket twin-checkout involving forward and backward operation. Applied Ergonomics 21(1): 7-14.

Thayer, W., 1989 (October). Everything you should know. Progressive Grocer, pp. :18-29.

The Impact of Technological Developments on Supermarkets, 1984 (September 27-8). Proceedings from a colloquium, Dublin, Ireland., (49 pages).

Wallersteiner, U.C. 1981 (December). An outline of ergonomic research as applied to the design of supermarket cashier work stations. Labour Research Bulletin, B.C. Ministry of Labour, pp.: 19-25.

Wallersteiner, U.C. 1989. An outline of ergonomic research as applied to the design of supermarket cashier workstations. Labour Research Bulletin, B.C. Ministry of Labour, pp.: 19-25.

Wells, R., Ranney, D., Norman, R. and Brawley, L. 1990 (March). Ergonomics of the Supermarket Cashiers' Environment. Ontario Retail Accident Prevention Association (ORAPA) and Centre for Applied Health Research (CAHR) and the Department of Kinesiology, University of Waterloo, Waterloo, Ontario.

Wilson, J.R. and Grey, S.M. 1984. Reach requirements and job attitudes at laser-scanner checkout systems. Ergonomics 27(12): 1247-1266.

Appendix A
Summary of recommendations from various studies

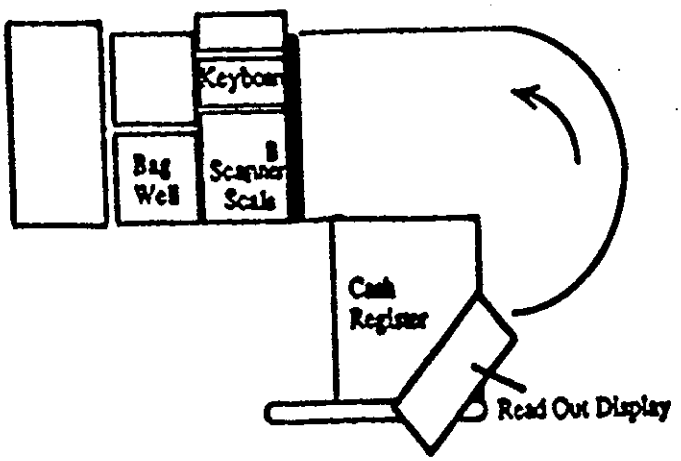
Checkstand Feature	Recommendation	Justification	Author/Year
Scanner placement	-scanner and scale combination in front of cashier flush with conveyor -height 31"-34" -height 34"-36" -scanning arc 20 cm-30 cm -scanner read area 8"-10" from cashier edge of checkstand	-eliminates twisting and reaching to weigh and scan -to minimize reaching	Baron et al. (NIOSH), 1991 Grant, 1993 FMI, 1992 Wells et al., 1990 FMI, 1992
Scanner type/orientation	-vertical or horizontal depending upon which has greater efficiency in reading bar codes and minimizes handling of scannable items -vertical scanner -scan large items with wand -place multiple windows on scanner at various angles -scanner/scale combination	-reduces handling and re-scanning -avoids contact with groceries and allows sliding -to reduce handling -checker perceives there is no need to deviate wrist	Baron et al. (NIOSH), 1991 Grant, 1993 Ergo Systems Inc., 1992 Wells et al., 1990 Marras et al., 1995 FMI, 1992
Keyboard placement	-in front of cashier, above scanner, adjustable up-down, right-left, toward-away from cashier and angle adjustable -height 47"-57" for women and 51"-63" for men -at or below elbow height so the forearm is level, horizontal if touch typing and angled toward right arm -55%-65% of cashier's height, within 35° downward vision and at a 10°-15° angle -keyboard within 10" of cashier at 40"-43" height; if more than 10", adjustable between 44"-56"; if above 44", tilt adjustment 0°-60°	-reduces shoulder flexion	Baron et al. (NIOSH), 1991 IBM-World Trade, 1981 Wells et al., 1990 FMI, 1992
Scale placement	-reach to far end no more than 17" if all items can be handled within 12" to right and left of cashier -rollers over scale	-to facilitate sliding vs. lifting	Baron et al. (NIOSH), 1991 Wells et al., 1990

Checkstand Feature	Recommendation	Justification	Author/Year
Bagging area	-locate bag stand to side of cashier with top of empty bags at height even with conveyor	-permits each item to be immediately bagged after scanning to reduce rehandling and lifting	Baron et al. (NIOSH), 1991
	-filled bags delivered to customer by belt or roller conveyor	-reduces lifting	Grant, 1993
	-bag stands at end of checkstand and wrapper	-elimination of bagging by cashier results in decreased repetition and awkward postures	Wells et al., 1990 Baron et al. (NIOSH), 1991,
	-lowered bag counter with hooks so bags can be slid off rack onto counter with hooks	-eliminates lifting of full bags	Ergo Systems Inc., 1992
	-bag stand 13"-17" lower than top surface (20" from floor)		-Guidance Note for Manual Handling in Retail Industry, Australia, 1992
	-bag stand at one side rather than in front of cashier	-reduces reaching over the bag in scanning	Wells et al., 1990
	-double bag racks	-reduce reaches to presort	
	-grocery carts with foldable sides or that connect to workstation	-reduces lifting	
	-use a wrapper with tribelt checkstand		
	-bagwell open to customer on express line, bagwells adjustable	-facilitates transfer to customer	
	-adjustable-height bag stand, top of bag flush with or slightly below top of scanner/checkstand (may be 2" above for tall workers). for plastic bags 32"-36" with adjustable base 20"-24"		Ergo Systems Inc., 1992 FMI, 1992
Height of checkstand	-working heights 90cm-97 cm with 15° slope	-reduces reaches and bending	Wells et al., 1990 Carrasco et al., 1995
	-height scanner and conveyor 96.5cm to 106.5 cm		
	-36" height (94 cm)	-reduces back and hand-wrist stress	
	-height adjustable		Ergo Systems Inc., 1992
	-adjustable floor with gas spring costs $1200 U.S. (1989)		Ergo Systems Inc., 1992 Harber et al., 1993
	-store with checkouts at three different heights and adjust work schedules to match up with heights of workers		Thayer, 1989
	-platform that slides in and out of workstation in 10 seconds (Reynold Corp., Washington)		
	-34"-36"		FMI, 1992

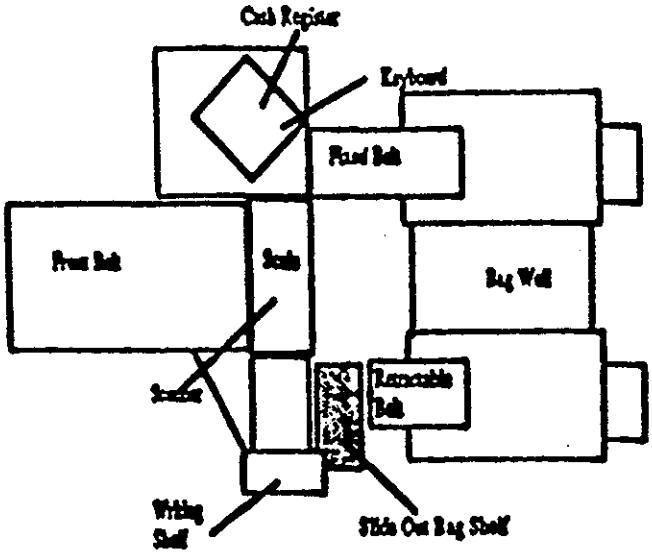
Checkstand Feature	Recommendation	Justification	Author/Year
Conveyor bringing items/diverter bar	-height of 34"-36" -guides to reduce reaches - need width to accommodate 2.5 loads of groceries and to offer a selection of items to cashier -max. reach 40 cm - grasping area 35 cm to 40 cm -reach within 18", use diverters electronic eyes close to scanner, or narrower belt		Baron et al. (NIOSH), 1991 IBM-World Trade 1981 Wells et al., 1990 FMI, 1992
Conveyor taking items away	-area between scanner and conveyor (reaction-release area) 40 cm -angle take-away belt or slide tray	-to minimize reach - so it follows the natural arc of the arm during discard following scanning	-IBM-World Trade 1981 FMI, 1992
Customer read-out	-in normal line of sight of seated operator -within 15° of horizontal field of view - max. 30°-35° -in front of cashier -positioned so checker can see without twisting		IBM-World Trade, 1981 Wells et al., 1990 Ergo Systems Inc. 1992 FMI, 1992
Cash drawer	-locate to side of cashier at height 32"-36" from floor with near edge of drawer no more than 18" from cashier -40 cm to 50 cm -located preferably within 18" reach, but not to obstruct product flow, top no lower than 28", 32"-36" preferred		Baron et al. (NIOSH), 1991 Wells et al., 1990 FMI, 1992
Sit-stand/chair, floor mats, etc.	-provide adjustable sit-stand bar or stool -sit-stand height 55 cm to 80 cm -padded mats to stand on -footrest width 45 cm and depth 35 cm, adjustable in height and inclination 15°-25° -footrest, adequate toe-space (4") and where feasible an adjustable sit-stand butt rest	-allows rest when possible (e.g. customer check writing) -sitting preferable, but must reduce reaches, twisting and limit weights handled -reduces leg fatigue	Baron et al. (NIOSH), 1991 Ergo Systems Inc. 1992 Wells et al., 1990 Baron et al. (NIOSH), 1991, Ergo Systems Inc. 1992 Wells et al., 1990

Checkstand Feature	Recommendation	Justification	Author/Year
Organization of work/breaks	-more frequent breaks and job rotation/enlargement -regular pauses and changes in working tasks -improve feedback, supervision, significance and autonomy -maximum one hour than rotate to bag 45 minutes than 15 min. break with overall max. 4.5 hr/day -restrict hours on tribelt -limit number of hours on express till to one hour	-to improve job satisfaction -to reduce repetition daily and over time	Wilson & Grey, 1984 Wells et al., 1990 Lannersten & Ringdahl, 1990 Wells et al., 1990 Ergo Systems Inc. 1992 Ergo Systems Inc., 1992
Work Practices/ Techniques	-scan and bag practice should be restricted -avoid reaching over conveyor to unload or load grocery items from/to customers cart -avoid reaching for items to be scanned instead of waiting for conveyor belt to bring them -scanning more than 2-3 times and not keying-in multiple purchases of a single item -train to reinforce location of codes -avoid lifting more than 10 lbs and slide item -key rather than lift and scan large items -train to use power grasp and not to twist wrist -develop store-level cashier safety awareness program, include ergonomic principles as part of cashier training -minimize handling of heavy/bulky items, such as 20 lb bags by establishing an upper limit and using alternative methods such as key-entry, detachable labels, hand-held wands, etc.	-stresses lower back -to minimize handling	Wells et al., 1990 Ergo Systems Inc., 1992 Baron et al. (NIOSH), 1991 Wells et al., 1990 FMI, 1992
Other	-encourage manufacturers to adopt standard labeling practices that will minimize the need to reposition items for scanning or rescan items that were unsuccessfully scanned. -symbols on natural bottom of item -good training, appropriate injury reporting and treatment and effective return-to-work policies -better technology to open plastic bags -establish a program and procedures for maintaining uniform product code symbol quality and price look-up file integrity	 -to reduce damaging wrist motions	Baron et al. (NIOSH), 1991 IBM-World Trade, 1981 Wells et al., 1990 Ergo Systems Inc., 1992 FMI, 1992

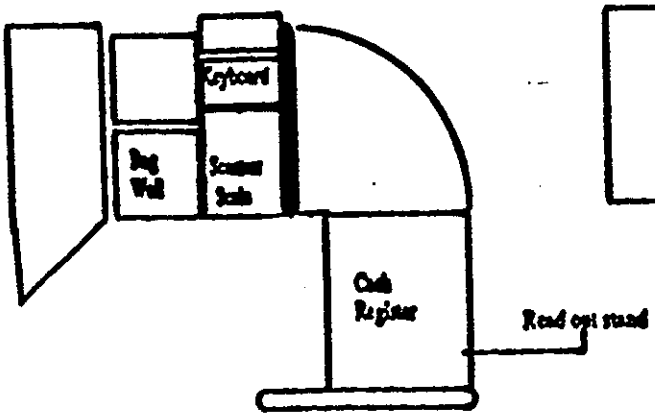
Appendix B
Diagrams of 4 checkstand types



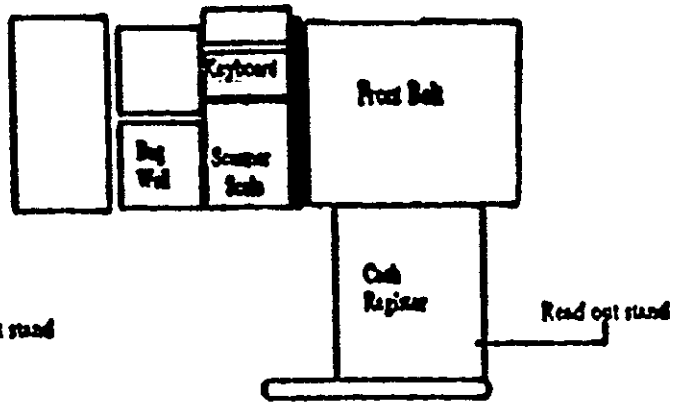
ROTARY



TRIBELT



COUNTER EXPRESS



BELT EXPRESS

Appendix C
Questionnaire

RETAIL FOOD SURVEY

CONFIDENTIAL
Musculoskeletal Health Reporting In Cashiers

The purpose of this questionnaire is to determine some of the factors in your work that could be contributing to accidents and injuries among Safeway employees. You do not have to sign your name, but please answer the questions honestly.

SELF DESCRIPTION

Would you please provide the following information:

1. Age: _____
2. Gender: Male ☐ Female ☐
3. Height: _____ft _____in or _____cm
4. Are you: right handed ☐ left handed ☐ both ☐

JOB DESCRIPTION

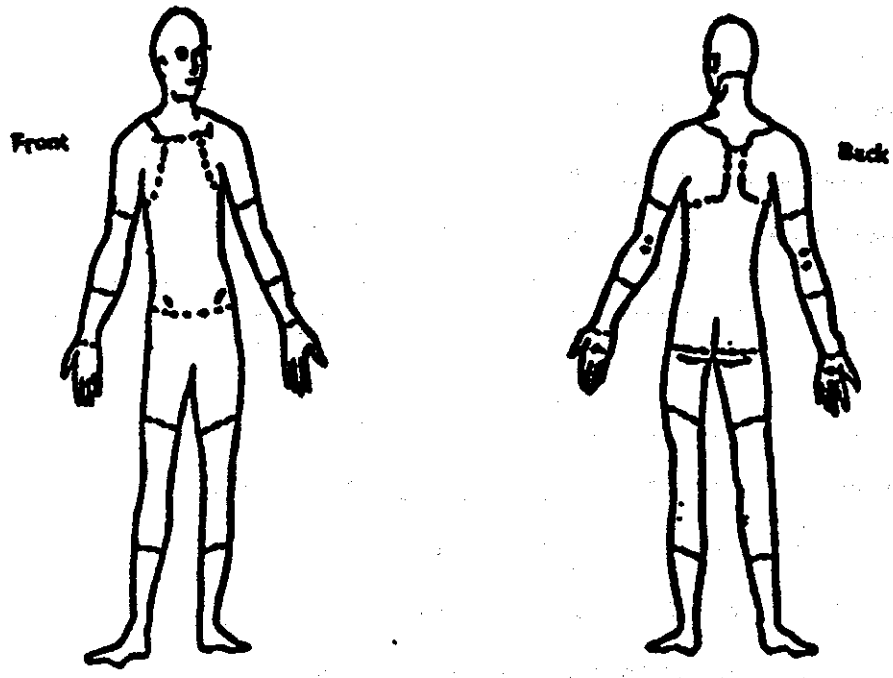
1. Occupation? _____ Department? _____
2. Number of years/months working as a cashier? _____ With this company? _____
3a. Are you employed: part time ☐ full time ☐ other ☐
3b. Over the past year, how many hours per week have you worked on average?_____
4. Did your previous job involve similar repetitive movements of your hands and/or arms? ☐ Yes ☐ No
5. If yes, what activities did you perform? _____
6. Checkstand style

Checkstand style	Time spent (hours/week)	Hand use		
☐ Tri-belt	_____	right ____%	left ____%	both ____%
☐ Rotary	_____	right ____%	left ____%	both ____%
☐ Front-loading	_____	right ____%	left ____%	both ____%
☐ Belt-express	_____	right ____%	left ____%	both ____%
☐ Counter-express	_____			

7. Which hand do you use most at work: right ____% left ____% both ____%
8. Do you have a bagger to assist you? ☐ Yes ☐ No ☐ 0-25% ☐ 26-50% ☐ 51-75% ☐ 76-100% of the time?
9. What percentage of the time do you work two hours without a break? ☐ 0-25% ☐ 26-50% ☐ 51-75% ☐ 76-100% of the time??
10a. In the last month, while working at the cash register, have you experienced significant discomfort or pain? ☐ Yes ☐ No

10b. If yes, where? Please indicate on the diagram using the number which corresponds to the level of discomfort for that body part.

1	2	3	4
Slightly Uncomfortable Slightly Sore	Uncomfortable Sore	Very Uncomfortable Very Sore	Extremely Uncomfortable Extremely Sore



10c. Do you have any additional comments? _____

_____

_____

11a. Did you see a medical professional to discuss the identified pain? ☐ Yes ☐ No

11b. How long was it before you sought medical attention after you noticed your pain? _____ weeks _____ months _____ years

12a. Did your doctor diagnose a condition/state/problem? ☐ No ☐ Yes

12b. If yes, please note and/or describe: _____

12c. How long have you had this condition or felt this way? _____ months _____ years

13. Was your supervisor or manager told about the pain which resulted in the injury? ☐ Yes ☐ No

14. In the last six months, how many days of work did you miss due to the injury symptoms or the injury itself? _____
To your knowledge, was the absence registered as: ☐ WCB Claim ☐ Sick Leave ☐ Weekly Indemnity (Group)
☐ Other ☐ None ☐ Don't Know

If you filed a claim, was it: ☐ accepted ☐ rejected

15. We are asking to have your ideas about what aspects or parts of your job you feel could be improved or are satisfactory. We are also interested in what changes you think would make the job of cashiers better:

15a. What aspects (if any) of the equipment or process required for scanning and weighing items do you feel could be improved? Why?

16. What aspects (if any) of the equipment or process required for bagging products do you feel could be improved? Why?

17. What aspects (if any) of the equipment or process required for totaling the bill, receiving payment, etc. do you feel could be improved? Why?

18. What aspects of the equipment or process or checkstand design do you find satisfactory?

19. Please describe any other aspects of the organization, working culture, training etc. which could be improved to make cashiering better:

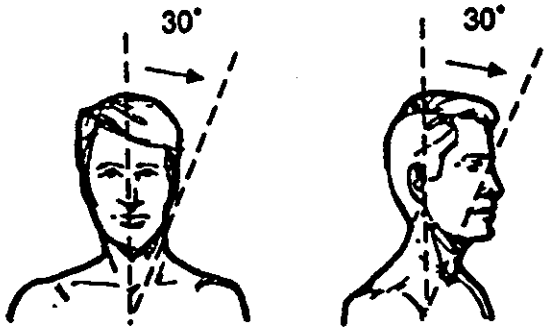
20. What changes to your job or workstation, while operating a cash register, would make it better? Please be specific. A diagram may be useful to describe your ideas.

21. Please add any additional comments:

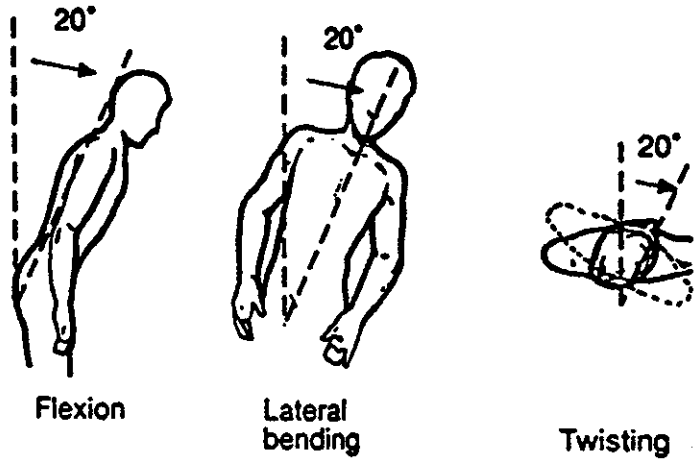
Thank-you for your participation in this study!

Appendix D
Postural Angles

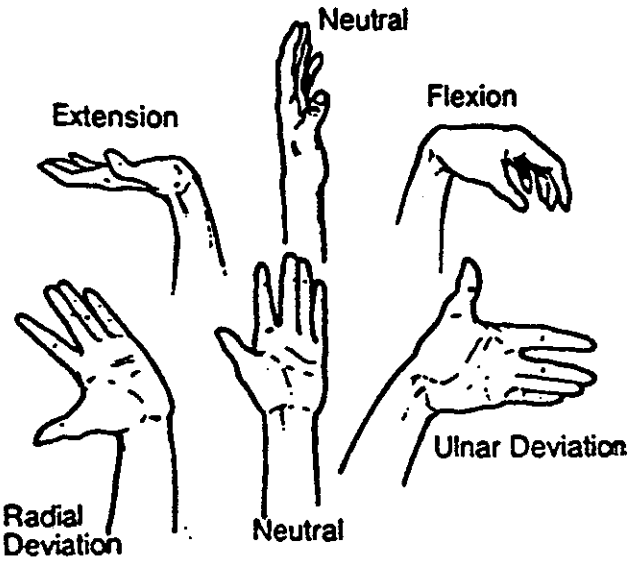
NECK



BACK



WRIST



SHOULDER