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CONSIDERATION THE POSTURE AND ERGONOMIC CONDITIONS OF STAFF WORKING WITH CHILDREN IN KINDERGARTEN

***Katarina Kacjan Žgajnar*[1]**
[1]University of Ljubljana, Facculty of Health Sciences, Ljubljana, Republic of Slovenia

Abstract. *Correct posture at rest and in motion allows muscles to work with minimum effort, protects the locomotor organs from damage and injury, and ensures the best positions for the internal organs. Posture can be consciously controlled and corrected. Kindergarten staff are often exposed to a lot of forced and unergonomic postures, which are part of the work nature. The aim of the research is to show the burdens and hazards of the educational staff's jobs. We analysed the educational staff in kindergartens in the Municipality of Ljubljana between 2018 and 2023. The survey involved 24 educators and 28 assistant educators. We used the method of momentary observation - a modified OWAS method. At the same time, we used the CORLETT method to assess work-related discomfort in their body parts. Participants were monitored throughout their working time. We found that in working positions and postures of the thoracolumbar spine, upper limbs, arms and cervical spine, the loads in one or more segments exceeded the physiological recommendations for both the teachers and their assistants, and that appropriate action should be taken. The results of the Corlett assessment of musculoskeletal disorders at educators show that discomfort in the lower and upper back, nape of the neck is prevalent at work. Educator assistants have more muscle discomfort than educators, probably due to the longer working hours. Educational staff are exposed to a variety of risk factors in the workplace that can lead to infections, injuries, increased stress and physical strain. Physical burden is one of the key causes of musculoskeletal disorders. We propose the introduction of short active breaks to relieve muscle strain. We also recommend education on the meaning and objectives of ergonomics in the workplace and practical demonstration of correct body postures at work to reduce static burdens on the limbs.*

Key words: *burdens, workplace measurement analysis, educational staff, ergonomics, kindergarten*

Introduction

In the field of occupational health, ergonomics is the process of designing work tasks and requirements to suit the working population. The aim of ergonomics is to reduce and prevent musculoskeletal disorders caused by a variety of factors. These factors may include: physical (working activities like pushing, pulling or lifting), psychosocial (mental well-being under the influence of social factors) and personal (age, gender, and body mass index). The aim of ergonomics is to prevent the discomfort and injuries that can be caused by work [1].

Musculoskeletal disorders (MSDs) are the most common occupational health problem in Europe. Millions of workers are affected. It is estimated that 25% of workers suffer from back pain and 23% from muscle pain [2]. Back pain is the most common complication of all MSDs and requires the most expensive to treat [3].

MSDs, which include inflammatory and degenerative disorders affecting the lower back, neck, upper and lower limbs, are among the leading causes of work-related injuries. They are not always caused by work, but still account for a large proportion of all registered work-related diseases [4].

Authors from Lebanon, Denmark and France [5] investigated risk factors for the occurrence of occupational back pain. They identified 14 personality risk factors (age, sex, weight, height, BMI, regular exercise, smoking, etc.) and 17 work-related risk factors (type of job, shift work, weekly working hours, daily working hours, job satisfaction, performance of physical interventions, daily working hours in a standing position, stress at work, overtime, prevention measures, etc.). Among all proven risk factors, low back pain at work is most frequently associated with type of work, the number of working hours per day and the number of hours per day spent standing. There is strong evidence [6, 7] that prolonged work and heavy lifting are negative factors in the development of low back pain.

MSDs are a major problem in the modern world, and workers who perform physically demanding work involving frequent lifting, pulling, bending, repetitive work, prolonged standing, etc. are particularly susceptible to these disorders. Non-observance of ergonomic principles leads to MSDs, to which the elderly are more susceptible, as they are often the result of inadequate loading and physical exertion during youth and throughout life. In addition to the above, gender (women are more susceptible), body weight, physical activity and other comorbidities are also thought to influence the occurrence of MSDs [8].

The pre-school teacher-educators plays a key role in the personal development of the child. The child identifies with and emulates the teacher. Success in the profession requires enjoyment in working with children, communication skills and social skills. Appropriate attitudes towards children, parents and other nursery school staff are important. Teaching involves a great deal of emotional and psychological strain, so good health is desirable. Due to the nature of the work, chronic diseases of the spine, vocal cords and hearing are more common. In addition, the constant need for creativity and innovation exposes educators to occupational burnout [9].

There are many physical risk factors associated with working with children, which are often associated with chronic musculoskeletal injuries [10]. Researchers cite lifting and carrying children [11, 12] and moving furniture [13] as the most common causes of MSDs (especially low back pain). It is very common for educators to lift loads heavier than 5 kg, most of them with the torso bent [13]. Lifting and carrying children is more common, especially in the early years [14]. The risk of back injury is four times higher when children heavier than 11 kg are lifted from the floor with a bent back and straight knees [12, 15]. Although the frequency of lifting is lower in the second age group (3 - 6 years), the weight of the children increases [12].

Older age, longer working life and female gender increase the risk of MSDs among educators. Length of working life influences the risk of neck and lower back pain, and age influences the risk of upper and lower limb pain [16].

Educational staff are often exposed to a number of forced and non-ergonomic postures that are part of the nature of their work. The purpose of our survey is to highlight the strains associated with their work.

Methods

Data Collection Methods and Techniques

Between 2018 and 2023, the modified OWAS was used to observe the postures and movements of educational staff in kindergartens in the Municipality of Ljubljana. 24 kindergarten teachers and 28 assistant teachers participated in the study. At the same time, work-related movement complaints were assessed using the CORLETT method. Observations were made throughout the working day.

Instruments

We used the two methods. The OWAS method is used to investigate workplace anomalies and provides a starting point for workplace improvements. Interval monitoring (every three minutes) records and evaluates statistical characteristics of critical postures (26 positions) and forces (3 prescribed ranges). The working postures and positions are divided into 4 thoracolumbar spine posture patterns, 5 cervical spine posture patterns, 4 upper limb posture patterns, 3 hand posture patterns, 8 lower limb posture patterns, 2 movement patterns and 3 force patterns [17, 18, 19, 20]. Observation is used to determine the actual daily loads on the musculoskeletal system at work [17, 19, 20, 21, 22, 23]. Monitoring takes place with one or more workers at the same time. The total number of observations depends on the expected validity of the results and the type of work. If the work is monotonous, repetitive and simple, fewer observations are needed [19].

The CORLETT method is used to assess musculoskeletal disorders and requires the worker to be monitored throughout the working day. During work, the worker is asked periodically (hourly) where he/she feels discomfort or pain and is given a special form with an outline of the human body with the parts of the back numbered to help him/her orientate. The observer is asked to indicate first the place where he/she feels the most discomfort or pain, and then the other places in turn, from greater to lesser discomfort or pain. He/she should indicate all the places where he/she feels discomfort or pain at that moment. The affected areas are recorded in a separate form. This method identifies which parts of the body are suffering discomfort or pain, and how it changes, intensifies or recurs over time [19, 20, 24].

Description of the sample

There were 52 participants, 11.5% male and 88.5% female. Of these, 46.2% (24) were educators with an average age of 42.8 years (28 to 56) and 53.8% (28) were assistant educators with an average age of 39.8 years (19 to 56). Two of the educators were male, four of the assistant educators were male and the rest were female. Educators have an average of 19 years of service (2-37) and have been in the profession for an average of 16.3 years (1-36), while assistant educators have an average of 17 years of service (0.5-35) and have been in the profession for an average of 13.2 years (0.5-32).

Description of the survey and data processing

The implementation of our research followed the planned steps. First, we talked to education staff and recorded their observations about where they thought change was needed in the workplace, how they felt about performing certain tasks and which activities they found most stressful. We then recorded the positions through participant observation. We only recorded when the participant was performing the job tasks. Only the most critical positions were chosen. One or more participants were observed simultaneously. Observations were recorded using lines on the forms (Figure 1). For activity groups 1, 2, 4 and 5.1 to 5.4 one line was recorded for each observation. In activity groups 3, 5.5 and 6 we only recorded activities when they occurred. For example, the participant's hands perform a function, the head is turned 45° or more, the worker overcomes forces of 100 to 199 N, etc. The sum of the observations of each group 1, 2, 4 and 5.1 to 5.4 was the same and represented the entire work process of the participants without a break (100%). 5.1 to 5.4 was equal to the sum of the observations of each group 1, 2, 4 and 5.1 to 5.4 and represented the whole working process of the participants without a break (100%).

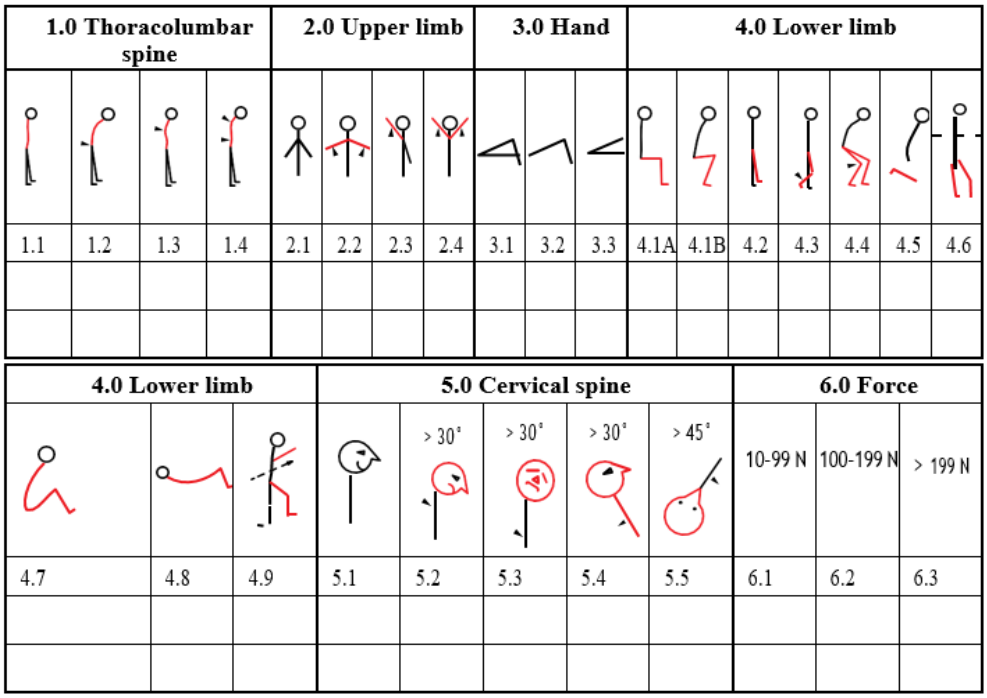

Figure 1: Representation of body postures according to the modified OWAS method [19, 20]

Each participant was observed for 7.5 hours, which is 450 minutes including a legal break. After the observation, the number of observations of each position was summed for each group from 1 to 6 and the proportion of observations in each group was obtained. The resulting values (percentages) of the representation of each position were entered into a scoring table and it was determined whether the calculated values occupied the acceptable, moderate, critical or area where further clarification was required. This identified the need for action or change in the participant's workplace. At the same time, any pain or discomfort in the extremities was recorded hourly on separate forms (Figure 2).

Descriptive statistics were used in the text to describe the baseline characteristics and to analyse the results. Student's t-test was used to determine the differences between the workloads of educators and assistant educators.

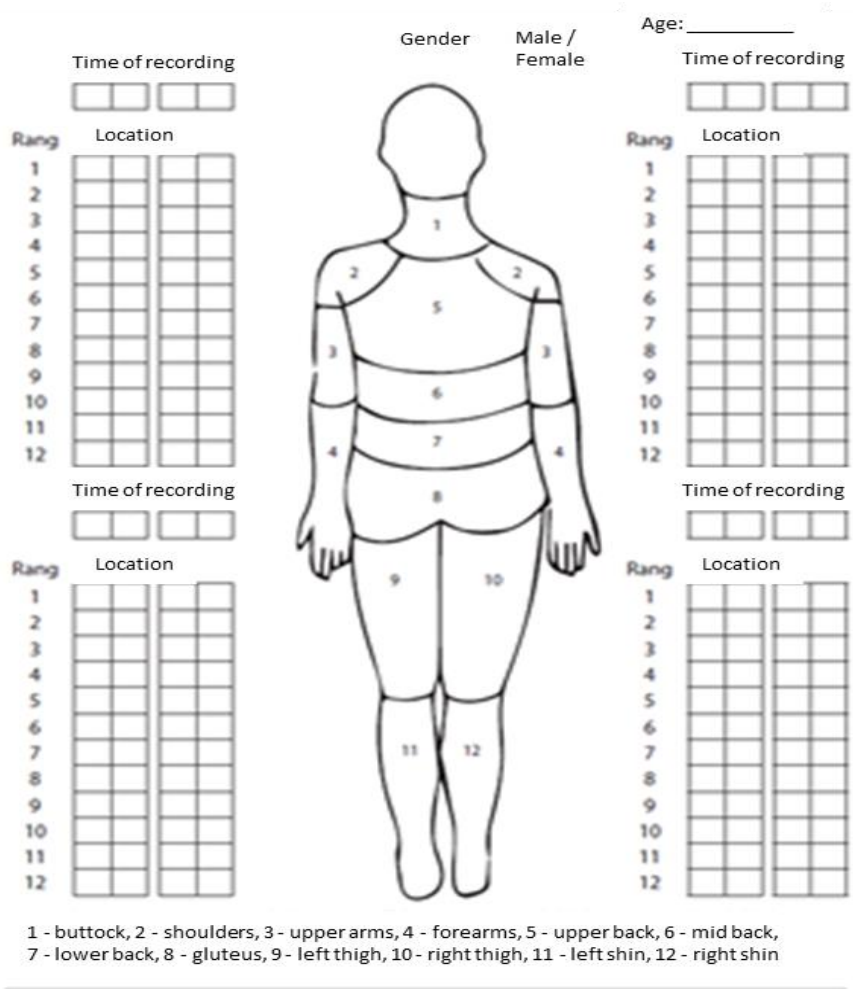

Figure 2: Workplace Musculoskeletal Discomfort Assessment Form according to the CORLETT method [20]

Ethical aspect

Ethics were considered at all stages of the research process, from research design, literature review, consideration of other research, participant involvement, data collection, data protection, data processing, data interpretation, writing up the discussion and its publication. The necessary permissions and consents were obtained to allow the observations to be carried out. We ensured anonymous and voluntary participation and full information about the purpose and objectives of the research.

Results and discussion

The participants experienced the highest loads in the lumbar spine, cervical spine and shoulders, as shown in Table 1. After the OWAS observations of the educators (EDUs) and assistant educators (Ass-EDUs), we found that 5 body postures stood out as health-critical loads. The tolerable loads were exceeded for postures of the thoracolumbar spine (1.2 - arched back posture more than 15° and 1.4 - arched back posture (flexion more than 15°) combined with torsion or lateral flexion more than 30°), upper limbs (2.2 - one or both upper arms raised below shoulder level) and two postures of the cervical spine (5.2 - ventrally head inclined over 30° and 5.4 - dorsally flexed head over 30°).
It showed that 58% of the EDUs and 64% of the Ass-EDUs had overloads in position 1.2, and the highest number, 96% of the EDUs and 89% of the Ass-EDUs, had overloads in position 1.4, which should not have been detected at all. This position is a combination of position 1.2 and 1.3 and can cause MSDs in the lower back. We found that participants often combined position 1.2 with 5.4 and in fact the last position was recorded in 54% of all participants. Forcing postures were observed in the educational staff while performing certain tasks: preparing for and assisting with feeding, especially children in the first age group (1-2 years), lifting children for care, assisting with dressing and putting on shoes.

Posture and movement depend on the functioning of the musculoskeletal system. While the upright posture is characteristic of the human species, the posture of each individual is completely individual. At any given moment, posture depends on the position of the joints, which are controlled by the muscular system, and on the tasks to be performed. A physiological posture is one in which the body is balanced in motion and at rest with minimal muscular effort. This protects the supporting structures from degenerative changes and damage. Non-physiological posture includes deviations in the position and shape of the spine, shoulders and lower limbs, which are the result of insufficient and incorrect muscle function [25].

Table 1: Mean percentage distribution, minimum and maximum of observed OWAS body positions for EDUs (N=24) and Ass-EDUs (N=28), within a 7.5-hour working day and tolerable load

Body position	Educators [%] (MIN; MAX) *N=24*	Assistant educators [%] (MIN; MAX) *N=28*	Tolerable load [%]
1.1 Upright back posture	52.1 (33; 70)	48.0 (20; 80)	100
1.2 Arched back posture (more than 15° of flexion)	**31.2** (15; 55)	**31.8** (15; 44)	30
1.3 Upright posture with torsion or lateral flexion more than 30°	10.1 (0; 20)	14.0 (0; 29)	20
1.4 Arched back posture (flexion more than 15°	**6.6** (0; 17)	**6.2** (0; 16)	0

combined with torsion or lateral flexion more than 30°)			
2.1 Upper arms next to the body	50.9 (27; 66)	53.2 (10; 93)	100
2.2 One or both upper arms raised below shoulder level, elbows not supported	**39.9** (21; 63)	**35.9** (6; 60)	30
2.3 One upper arm above shoulder level	6.0 (0; 15)	7.6 (0; 23)	30
2.4 Both upper arms above shoulder level	3.2 (0; 12)	3.3 (0; 13)	20
3.1 Fine or coarse grip with one or both hands	48.0 (25; 68)	49.1 (21; 68)	70
3.2 Typing with one or both hands	4.6 (0; 18)	2.1 (0; 24)	70
3.3 Other activities with one or both hands (pushing, pulling, etc.)	10.3 (0; 21)	6.7 (0; 24)	70
4.1A Physiological sitting	6.1 (4; 24)	7.3 (1; 17)	80
4.1B Non-physiological sitting	19.2 (5; 37)	21.3 (6; 36)	30
4.2 Standing on both lower limbs	28.0 (4; 63)	22.5 (7; 41)	80
4.3 Standing on one lower limb	13.0 (0; 34)	20.2 (0 ;41)	30
4.4 Standing on one or both lower limbs with significant flexion at the hips, knees and ankles	3.5 (0; 11)	6.0 (0; 19)	10
4.5 Kneeling or squatting	4.3 (0; 19)	5.5 (0; 19)	30
4.6 Walking on level ground and climbing slopes of up to 30°	15.2 (0; 36)	14.6 (0; 34)	80
4.7 Sitting on the floor	2.5 (0; 8)	2.1 (0; 11)	10
4.8 Lying on the back when working overhead	0.2 (0; 2)	0.2 (0; 2)	10
4.9 Crawling, climbing on a slope with an inclination of more than 30°	0.3 (0; 4)	0.4 (0; 3)	10
5.1 Upright, neutral head position	48.8 (18; 78)	54.7 (15; 96)	100
5.2 Ventrally head inclined over 30°	**33.2** (10; 60)	**27.7** (3; 63)	20
5.3 Laterally inclined head over 30°	6.2 (0; 18)	5.8 (0; 18)	20

5.4 Dorsally flexed head over 30°	**11.8** (0; 28)	**11.9** (0; 28)	10
5.5 Rotated head over 45°; always in combination with one of the positions 5.1 to 5.4	20.1 (7; 38)	27.7 (10; 50)	30
6.1 Force overcoming from 10N to 99N	12.4 (2; 38)	12.6 (3; 38)	70
6.2 Force overcoming from 100N to 199N	2.6 (0; 9)	4.9 (0; 33)	30
6.3 Force over 200 N	0.2 (0;5)	0.0 (0;0)	10

The following tables show the results of the CORLETT method, namely the mean scores of musculoskeletal discomfort by hour for the whole working day for teachers and assistant teachers (Table 2) and the mean scores of musculoskeletal discomfort by body part for the whole working day for educational staff (Table 3).

The Student's t-test showed statistically significant differences only for the CORLETT scores, namely for musculoskeletal discomfort by hour between EDUs and Ass-EDUs.

Table 2: Mean scores of musculoskeletal discomfort per hour for the whole working day for educational staff.

Time/ hour	Educators	Assistant edducators
0	7.7	8.1
1	7.4	7.3
2	**11.3**	**12.6**
3	**10.8**	**15.7**
4	8.8	**16.8**
5	**14.3**	**17.5**
6	**14.5**	**22.6**
7	2.5	**19.6**
8	0.5	**20.9**

Table 3: Mean scores of musculoskeletal discomfort by body part for the whole working day for educational staff.

Body part	Educators	Assistant edducators
1 – nape of the neck	**10.4**	**25.6**
2 - shoulders	4.7	2.2
3 - upper arms	0.8	2.5
4 - forearms	0.9	4.9
5 - upper back	**9.7**	**32.9**
6 - mid back	0.0	**9.9**
7 - lower back	**23.8**	**39.6**

8 - gluteus	3.9	1.8
9 - left thigh,	8.0	1.9
10 - right thigh,	9.1	1.8
11 - left shin,	3.3	8.5
12 - right shin	3.0	7.9

We found that Ass-EDUs had more physical complaints, which may be related to their longer presence on the wards. This is because EDUs also have to spend part of the day on preparation and other administrative tasks and are on the ward for a shorter time than Ass-EDUs. The most uncomfortable time for EDUs is between 5 and 6 working hours (lunch and rest periods). For Ass-EDUs, on the other hand, discomfort is already present after the third working hour and lasts until the end of the working day. There is also more discomfort after the 6th and 7th hour because the Ass-EDUs are usually left alone in the ward after the children have rested, which means that they have to put all the beds in the wardrobe themselves, and they are also left alone to look after the children and help them to eat. This is especially a problem in the first age group, where the children are not yet independent. It turns out that the most painful parts of the EDUs are the lower back, neck and upper back. Ass EDUs have more musculoskeletal pain, especially in the lower and upper back, followed by the neck and mid-back.

Occupational activities also have an impact on body postures, as do certain MSDs and diseases with neurological consequences. Non-physiological posture affects tissue changes in bones, ligaments and muscles, and is clinically reflected in pain syndromes [26].

Musculoskeletal pain also affects the performance of nursery school staff. Although pain can be sudden, it is the result of a combination of factors such as poor posture, poor body mechanics, stressful life and work, loss of mobility and a general decline in physical activity. However, most of these factors are within our control. We can improve our posture and body mechanics, we can improve the ergonomics of the workplace with the help of our colleagues. Finally, we can exercise regularly to improve our flexibility and overall fitness. The key is to educate educators [27]. Educational programmes should be implemented in kindergartens that focus on teaching techniques to perform daily routines without negative effects on the musculoskeletal system. Educational programmes should address adaptations in working with children, changes in the work environment and adaptations in daily routines. Educational staff should be trained in the use of correct body mechanics when lifting and carrying, which would be helpful in ensuring correct posture and identifying tasks that may increase the risk of developing MSDs [12, 26]. It is also important to get the ergonomics of the workplace right, and to take certain measures, including redesigning equipment in kindergartens. This would result in a more ergonomically appropriate environment that minimises the occurrence of movements that put strain on the bodies of educational staff and can cause musculoskeletal injuries [26]. To reduce the physical risk factors for MSDs, they recommend the use of an adapted step stool for children and a height-adjustable chair for the educational

staff to help with shoes, dressing, eating and washing. This way they avoid bending down and can help the child in a sitting position. Lifting children from this position is also much less stressful on the back. Lifting a load that is at least 30 cm off the ground is much less stressful on the back than lifting from the ground. Too high a changing table causes upper back and shoulder pain, while too low a changing table puts stress on the middle and lower back, so a changing table that the child can climb on their own is recommended [28, 29].

Many OSH professionals are involved in assessing workplace risks, eliminating hazards and taking preventive measures. These experts are able to contribute and resolve (solvable) environmental workplace obstacles and provide worker´s safety, health and well-being. At the same time, they combine ergonomic knowledge and act in an appropriate preventive manner [30, 31].

Conclusion

Ergonomics is about relieving the worker and providing a comfortable and pleasant working environment. Ergonomics helps to design the workplace so that the worker performs as few forced postures as possible, or replaces them with comfortable postures. This helps to reduce absenteeism, disability and occupational illnesses that might otherwise occur in a particular workplace. A holistic approach considers mental and physical health through ergonomic measures, promotion of physical activity and awareness raising.

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RAZMATRANJE ERGONOMSKE POZICIJE ZA OSOBLJE KOJE RADI SA DJECOM U VRTIĆU

Katarina Kacjan Žgajnar[1]
[1]Univerza u Ljubljani, Zdravstveni fakultet, Zdravstvena pot 5, 1000 Ljubljana, Republika Slovenija

Sažetak. *Dobro držanje u mirovanju i u pokretu omogućava mišićima da rade uz najmanje napora, štiti lokomotorne organe od oštećenja i ozljeda i osigurava najbolji položaj unutrašnjih organa. Možemo svjesno kontrolirati i ispravljati svoje držanje. Vaspitno osoblje u vrtićima ima dosta iznuđenih držanja i neergonomskih položaja, koji su dio prirode posla. Cilj istraživanja je pokazati opterećenje i štetnost poslova obrazovnog osoblja. U periodu 2018 – 2023. godine izvršena je kvantitativna analiza odgojno-obrazovnog osoblja u vrtićima Općine Ljubljana. U istraživanju je učestvovalo 24 nastavnika i 28 pomoćnih nastavnika. Korištena je metoda trenutnog posmatranja - modifikovanu OWAS metodu. Istovremeno, metodom CORLETT, procijenjena je i nelagoda u njihovim dijelovima tijela. Učesnici su praćeni tokom cijelog radnog vremena. Utvrđeno je, da u položajima torakolumbalne kičme, gornjih udova, ruku i vratne kičme, opterećenja u jednom ili više segmenata premašuju fiziološke preporuke kako za nastavnike tako i za njihove asistente, te da je potrebno poduzeti odgovarajuće mjere. Položaji donjih udova i savladavanje sile ne predstavljaju velika opterećenja za većinu zaposlenih. Rezultati Corlett metode kod vaspitačica pokazuju, da se tokom rada ističe nelagodnost u donjem i gornjem delu leđa i potiljku. Asistenti vaspitačica imaju veću nelagodu u mišićima nego vaspitačice, vjerovatno zbog dužeg radnog vremena. Obrazovno osoblje izloženo je različitim faktorima rizika na radnom mjestu, koji mogu dovesti do infekcija, povreda, povećanog stresa i fizičkog opterećenja. Fizičko opterećenje je jedan od ključnih uzroka mišićno-koštanih poremećaja. Predlaže se uvođenje kratkih aktivnih pauza za rasterećenje mišića leđa, vrata, ramena, donjeg dijela leđa i potkoljenica i jačanje mišića prednjeg dijela tijela, posebno trbušnog zida. Preporučuje se i edukacija o značenju i ciljevima ergonomije na radnom mjestu, kao i praktičnu demonstraciju ispravnih položaja tijela na poslu, koji smanjuju statička opterećenja kretanja.*

Ključne riječi: *opterećenja, mjerna analiza radnog mjesta, vaspitno osoblje, ergonomija, vrtić*