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Does Wearing a Mask Affect Balance and Reaction Time?

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ABSTRACT

Introduction: A mask is a protective equipment that covers the mouth and nose and is routinely used in workplaces, public transport and other communal settings preventing harmful particles, dust, droplets, bacteria, viruses, fog, gas, smoke and steam from entering the respiratory system. However, wearing a mask may impair the visual field, potentially affecting balance and reaction time. Our aim is to determine whether the use of masks affects people's balance and reactions. Methods: Twenty-five healthy participants (14 female, 11 male) underwent two assessments: one while wearing masks and another without masks. Static balance was assessed using the BeCure Balance System, reaction time was measured using the BlazePod™, and dynamic balance was evaluated through the Functional Reach Test (FRT).

Results: Statistical analysis was performed using the Wilcoxon Test. There was a significant difference in the results of center of pressure displacements ($p<0,05$). FRT comparison had a significant difference also ($p<0,05$). There was no significant difference in the result of reaction time.

Discussion and Conclusion: Any deterioration in visual field may lead to falling especially in vulnerable people. These patients and their caregivers must be aware of this hazard and they should be informed meticulously about optimal mask using.

Keywords: Balance, N95, reaction time, wearing mask

Introduction

Balance is defined as the ability to keep the body's center of gravity within the limits of the support surface by using many sensory, motor, and biomechanical components (1). Visual, vestibular, and proprioceptive systems play a role in maintaining balance by providing fast and accurate information (2). Reaction time has been defined as a measure of perception, decision making, and other cognitive processes (3). It reflects the flow rate of neurophysiological, cognitive, and information processes created by the stimulating effect of the person's sensory system. Receiving information (visual or auditory), processing it, making decisions, and responding to motor action are processes that follow each other and constitute reaction time (4). As auditory and visual stimuli increase, reaction time decreases (5). The visual system, which is the ability to distinguish between the movement of an object, the movement of the eye relative to the head, or the movement of the head and eye together, is of great importance in maintaining posture and balance (6).

Mask is a protection tool that seals the mouth and nose to prevent harmful particles, dust, droplets, bacteria, viruses, fog, gas, smoke and vapors from entering the respiratory system (7,8). Professions across various sectors utilize masks for different purposes, reflecting the diverse applications of this protective equipment. Healthcare professionals, such as doctors, nurses, dentists etc., workers in occupations such as the food industry, construction and service sectors wear masks to protect themselves from inhaling infectious aerosols or contaminants (9). Overall, the widespread use of masks in workplaces, public transport, and other communal settings has become a critical preventive measure to reduce the transmission of infectious diseases like

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Coronavirus disease 2019 (COVID-19) (10,11). Although using mask has an crucial and indispensable place in the control of harmful particles and infectious respiratory diseases such as COVID-19, studies show that using mask can hinder people's lower peripheral visual field (12–14).

Information from the lower peripheral visual field is important for detecting dangers in people's immediate area and safely adjusting steps to avoid these dangers while walking. Using mask narrows people's control area and may increase the possibility of tripping or falling (15). When a person has difficulties with visual perception, the ability to maintain upright balance, to perceive space correctly or to manipulate objects also are affected. Using any accessory on the face (such as a hat) may restrict the field of view, negatively affect visual perception, and this may restrict the individual's activities of daily living (16). The edge of the mask riding up the patient's face may cause artifacts in the inferior visual field (14). When the lower field of view is blocked, shorter steps, greater head tilt, and slower walking speed are expected (17). Equipments such as masks, glasses, and hats not only block the field of vision, but also cause slowing down and prolongation in reaction time (18).

Visual system plays an crucial role in sustaining a stable body balance by constantly providing the nervous system with information regarding the environment, body movement, and body position (19). Limitations in the visual field can contribute to balance-related problems by causing the inability to receive necessary visual input and thus reducing the proprioceptive and vestibular inputs (20). This situation increases people's risk of falling and may affect their participation in society and quality of life. To our knowledge, there is no current study in the literature investigating the relationship between wearing a mask and balance and reaction time. Therefore, this study aimed to investigate whether wearing a mask affects balance and reaction time. Our hypothesis was the wearing an N95 mask negatively affects individuals' static and dynamic balance performance and alters their reaction time by restricting the visual field.

Material and Methods

This study was carried out in the Istanbul Medipol University. 25 healthy participants (14 female; 11 male) were included in this study. Demographic informations and daily mask-wearing time were recorded. Participants included in the study were healthy individuals aged between 24 and 30 years who reported using a face mask for at least four hours daily. All participants provided written informed consent prior to enrollment and had no known history of neurological, vestibular, or musculoskeletal disorders. Individuals were excluded from the study if they had a previously diagnosed or suspected balance disorder, uncorrected visual impairments, or any recent injuries affecting mobility or balance. Additionally, those who required assistive devices such as a cane or walker, or who were pregnant at the time of the study, were not eligible for participation. All participants had to do a test run before participating and the order of the measurements was different between each participant to avoid learning effects.

Two assessments were obtained per participants. All participants were first evaluated while wearing N95 masks (defined as respirators with an N95 filter facepiece certified by the National Institute for Occupational Safety and Health and the European standard). N95 mask was fixed starting 1.5 cm below the midline of the eyes, so that it fits the face snugly and provides a tight face seal. Thus, all participants were ensured to use the mask with a standard practice. Participants were asked to wear N95 masks for at least four hours before evaluation. At the end of the first evaluation, participants removed their masks and the second evaluations were performed without the mask. A 30-minute break was given between each assessment to adapt to the unmasked visual field (Figure 1).

Static balance was evaluated using the Becure Balance System. This system is a customed assessment software integrated with the Nintendo Wii Balance Board. Static balance was assessed by measuring the maximal amplitude of anteroposterior and mediolateral displacements from the center of pressure (COP). The pattern of COP was recorded while patients stood still for 30 seconds, with their eyes open (21).

Reaction Time was evaluated using the BlazePod™ while participants sat down by using pods on the table. Blaze Pod is a new technology which has pods and measures response time. The system lighted up in a random order not known by the researchers or the participants. Participants were asked to touch the pods lit up. Reaction time was recorded by BlazePod™ automatically. Three trials were performed, an average of these results

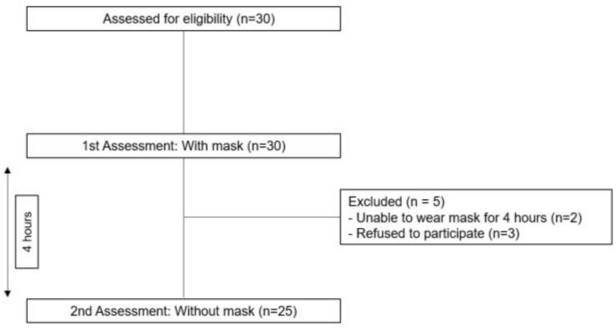

Fig. 1. Study Design

was used. Test-retest reliability for BlazePod™ was performed by de-Olivera et al. (22).

To evaluate dynamic balance, Functional Reach Test (FRT) was used. It has been tested for both validity and reliability. FRT represents the maximum distance a person can reach at arm's length while maintaining a stable base of support in a standing position. In the application of the test, the individual is asked to be in a parallel position with feet shoulder-width apart near a wall. The individual has a measuring stick attached to the wall at shoulder level. The individual is asked to make a fist with his hand and flex his shoulder to 90 degrees so that it does not touch the wall, and bring the third metacarpal finger joint of his hand to the starting point of the measuring stick. The assessor records the starting point. Then, the individual is asked to lean forward as much as possible without taking any steps and the endpoint is recorded. The difference between the starting position and the ending position is measured in cm. The test is repeated three times and average of the results were taken in consideration (23). The study design is shown in Figure 1.

Study Protocol: The study protocol has been approved by the local ethic committee of Istanbul Medipol University and has been performed in correlation with Declaration of Helsinki (protocol number:10840098-772.02-E.43565, date:04/09/2020). The protocol of the study was registered at ClinicalTrials.gov (NCT06522802). Informed written consent has been obtained from all participants.

Sample Size Estimation: The minimum sample size for the study was determined using G-Power version 3.1.9.4. In our preliminary investigation, encompassing 10 participants, the results of the FRT indicated a measurement of 18.67±3.9 cm with participants wearing masks, while the average was 21.44±4.6 cm without masks. Based on these findings, the effect size was computed as 0.832. With α error set at 0.05 and 1- β error set at 0.95, the calculated minimum number of participants necessary for this study was determined as 22.

Statistical Analysis: To assess the differences between the evaluations, Wilcoxon Test was used. The significance threshold was set at 0.05, with no adjustment for multiple comparisons. Statistical significance was accepted at $p<0.05$. The Statistical Package for the Social Sciences (SPSS) for Windows, version 22, was used for statistical analysis.

Results

The demographic and clinical features of the patients are shown in Table 1. When the data were evaluated using the Wilcoxon Test, there was no significant difference in the result of reaction time. However, there was a significant difference in the results of COP displacements ($p<0,05$). FRT comparison had a significant difference also ($p<0,05$). All statistical analyses are shown in Table 2.

Discussion

Considering the status of wearing a mask, our study shows notable distinction in balance but we found no difference in reaction time. Despite existing several studies regarding the impact of using masks on visual field, there is no specific research especially examining the effects of masks on balance and reaction time. Young et al. (14) found that the poorly fitted face mask can cause visual field artifacts. Boxrud et al. (24) showed that N95 mask use was associated with increased lower altitude field of view accuracy errors compared to people who did not use a mask.

Although there are some studies emphasizing that visual field decrease related with several reasons can negatively effects the balance level, there is no study concerning the effect of mask usage on balance (25,26). Studies show that narrowing of the visual field can affect balance. Failure to receive sufficient proprioceptive and visual information from the visual system increases the risk of falling and causes safety problems (27). Willis et al. (28) stated that affecting the visual field caused a decrease in the vestibulo-ocular reflex, and this resulted in a decrease in the balance level. Sorbello et al. (29) showed that the affected visual field has a negative effect on static balance and increases the number of steps taken per meter in individuals. Roh (16) investigated the

Table 1: Main Characteristics of Participants

		Mean	SD
Age		27,36	1,35
Mask usage time (hour/day)		6,4	1,19
		n	%
Sex	Male	11	%44
	Female	14	%56
Dominant side	Right	23	%92
	Left	2	%8

Table 2: Comparisons of outcomes

		Assessment 1 (With mask)	Assessment 2 (Without mask)	p value
		Mean±SD	Mean±SD	
FRT (cm)		15,72±2,09	25,92±3,65	0,000*
COP displacement	M-L	-0,21±0,3	0,16±0,28	0,028*
	A-P	-1,88±1,76	-0,42±0,91	0,036*
Reaction Time		21,92±3,02	21,48±2,60	0,079

COP: Center of pressure, M-L: Medio-lateral, A-P: Antero-posterior, *= p<0,05

effects of different types of hats on balance and eye-hand coordination and indicated that wearing the different types of hats lowered balance ability and visual perception compared to using none hat. Similar to literature, in our study, we found that the narrowing of visual field due to mask use reduced the balance level. The main reason for this is prevention of receiving adequate visual input because of diminished visual field, and also decline in balance level through interconnection of visual field and balance system.

On examining the conducted studies, it can be said that mask use is associated with many changes other than decreased balance (30). One important area of change is pulmonary capacity. It has been observed that long-term use of the mask causes changes in pulmonary parameters and cardiopulmonary exercise capacity (31). Rosa et al. (32) in their study, they showed that the use of N95 increased the level of perceived exertion in moderate activities.

When the literature was searched, few studies were found monitoring the relationship between mask use and reaction time (18). It was shown that as visual-sensorimotor impulses increase, reaction time decreases. Karmakar et al. (33) showed that the reaction times of people wearing masks were higher than those of people not wearing masks. Contrary to the literature, our results showed no significant difference in reaction time. Because we applied the test while the participants were in sitting and they could position their heads and visual fields as they wish. We think that there may be a difference in dynamic reaction time measurements.

Public health guidelines include warnings that face masks may less obstruct peripheral vision and increase the risk of falls and other accidents (15). In addition, studies have reported that if the masks are securely attached to the patient's face and nose, the significant deteriorations in visual field integrity caused by the masks are eliminated (13,14). For this reason, it is important to use masks at a standard and optimum level in daily activities that require wide range of vision, such as climbing stairs and driving, in order to reduce these risks (12).

Regarding limitations, our study targetted to evaluate short-term effects of the mask on balance and reaction time. We lack understanding of long term effects. Also, these results are valid for only N95 mask. There is no information about surgical masks and the others.Use of face masks against airborne infections and all kinds of harmful particles is very important to prevent their spread in community and among people working in certain professions. However face masks reduce the balance level through narrowing the visual field and this may give rise to increased risk of falling. We believe that comparative determination of the effects of using different types of masks on balance and reaction time is important. In addition, further studies focused on visual and vestibular effect of wearing masks should be conducted.

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