Spor ve Performans Araştırmaları Dergisi,
Journal of Sports and Performance Researches

e-ISSN: 1309-8543 Spor ve Performans Araştırmaları Dergisi,
Aralık 2023, 14(3): 381-390

Does Surgical Mask use Affect Balance and Mobility in Elementary School Children?

İlkokul Çocuklarında Cerrahi Maske Kullanımı Denge ve Mobiliteyi Etkiler mi?

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Makale Bilgisi/Article Information

Makale Türü/Article Types: Araştırma Makalesi/Research Article
Geliş Tarihi/Received: 25 Nisan/April 2023
Kabul Tarihi/Accepted: 6 Aralık/December 2023
Yıl/Year: 2023 | **Cilt – Volume:** 14 | **Sayı – Issue:** 3 | **Sayfa/Pages:** 381-390

Atıf/Cite as: Menek, B., Menek Yılmaz, M. "Does Surgical Mask use Affect Balance and Mobility in Elementary School Children?" Ondokuz Mayıs University Journal of Sports and Performance Researches, 14(3), Aralık 2023: 381-390.

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Etik Kurul Beyanı/Ethics Committee Approval: "Araştırma için İstanbul Medipol Üniversitesi Girişimsel Olmayan Klinik Araştırmalar Etik Kurulu'ndan 17/12/2021 tarihli ve 1263 karar sayısı ile etik kurul izni alınmıştır."

https://doi.org/10.17155/omuspd.1287395

DOES SURGICAL MASK USE AFFECT BALANCE AND MOBILITY IN ELEMENTARY SCHOOL CHILDREN?

ABSTRACT

Health experts and institutions recommend face coverings for kids above the age of 2 during the COVID-19 pandemic. The objective of this research is to examine the impact of wearing surgical masks on functional movement and stability in primary school-aged children. A sample of sixty healthy elementary school children aged between 9-12 were recruited. The variables of the study were six minutes walking test (6 MWT), 30-second sit to stand test, single leg stance test (SLST) and a dyspnea assessment. All assessments were contrasted between the two testing scenarios [wearing a surgical mask (SM) and not wearing a mask (NM)]. A statistically significant difference was observed when comparing the 6 MWT (p=0.00) and the 30-second sit-to-stand test (p=0.00) outcomes for both NM and SM situations. There was no significant difference in SLST between testing conditions (p>0.05). Also, the rating of perceived dyspnea values with the mask was significantly greater than the test condition without a mask (p<0.05). The use of a mask can cause differences in performance.

Keywords: 30-Seconds Sit to Stand Test, Six Minutes Walking Test, Single Leg Stance Test, Surgical Mask.

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İLKOKUL ÇOCUKLARINDA CERRAHİ MASKE KULLANIMI DENGE VE MOBİLİTEYİ ETKİLER Mİ?

ÖZ

Halk sağlığı uzmanları ve kuruluşları, COVID-19 sırasında 2 yaşından büyük çocuklar için evrensel maske kullanımını önermektedir. Bu çalışma, ilkokul çocuklarında cerrahi maske kullanımının fonksiyonel hareket ve denge üzerine etkilerini belirlemeyi amaçlamaktadır. Yaşları 9-12 arasında değişen altmış sağlıklı ilkokul çocuğu çalışmaya dahil edildi. Çalışmada fonksiyonellik için altı dakika yürüme testi ve 30 saniye otur kalk testi, denge değerlendirmesi için tek ayak üstünde durma testi (SLST) ve nefes darlığı için Vizüel Analog Skalası (VAS) kullanıldı. Tüm değerlendirmeler cerrahi maskeli ve maskesiz olarak karşılaştırıldı. Altı dakika yürüme testi (p=0.00) ve 30 saniye otur kalk testi (p=0.00) sonuçları incelendiğinde, maskeli ve maskesiz durumları arasında istatistiksel olarak fark vardı. SLST test koşulları arasındaki değerler birbirine benzerdi (p>0.05). Ayrıca, maske ile algılanan dispne değerlerinin derecesi, maskesiz test koşulundan daha yüksekti (p<0.05). Maske kullanımı performans parametrelerinde değişikliklere neden olabilir.

Anahtar Kelimeler: 30 Saniye Otur Kalk Testi, Altı Dakika Yürüme Testi, Cerrahi Maske, Tek Ayak Üstünde Durma Testi.

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INTRODUCTION

Coronavirus Disease 2019 (COVID-19), succeeding the 2009 Influenza A H1N1 pandemic, represents the second pandemic of the 21st century. On March 12, 2020, the World Health Organization (WHO) declared COVID-19 a pandemic (Kim et al., 2020). The causative agent is the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which shares a close relationship with bat SARS-related coronaviruses (Alsharif and Qurashi, 2021). Rapid transmission is attributed to high infectivity, asymptomatic spread, and low virulence. Due to the swift transmission, there are concerns that healthcare systems may lack the resources and personnel to accommodate the influx of COVID-19 patients, leading to elevated morbidity and mortality rates (Ranney et al., 2020). Quarantine, isolation, and face mask usage are preventative measures that can mitigate the impact of infectious disease outbreaks (Parmet and Sinha, 2020). These measures were employed to limit community transmission of SARS in 2003 and pandemic Influenza A H1N1 in 2009 in Hong Kong and other global locations. However, the effectiveness of community-wide population masking during previous epidemics or the current COVID-19 pandemic remains unexplored (Chan et al., 2020).

Personal protective equipment, such as face masks, is recommended to curb the spread of highly contagious pathogens. In areas with confirmed or suspected community transmission, the WHO advises wearing face coverings in public and healthcare masks for both high-risk and symptomatic individuals. Consequently, mask usage has been proposed in numerous countries, with many mandating their use in everyday life and in healthy environments (Lim et al., 2021). The role of children in the transmission of COVID-19 remains a subject of debate. Findings on asymptomatic carriage, social distancing, handwashing, and mask usage have implications not only for adults but also for younger populations (Ma et al., 2020). The guidance provided by the WHO and United Nations Children's Fund (UNICEF) on August 21, 2020, also underscored the paucity of knowledge regarding face mask usage in children (Eberhart et al., 1992).

While adult patients have reported adverse effects associated with face mask usage (Kyung et al., 2020), there is limited evidence to suggest similar negative impacts on children. Wearing a mask may obstruct inspiratory and expiratory pathways, causing discomfort for some individuals. Increased pressures during inspiration and expiration can result in shallow, forceful breathing and heightened activity of respiratory accessory musculature (Person et al., 2018). Moreover, several participants in one study reported difficulty tolerating face mask usage during daily activities or outdoor physical exercise. In this study, children aged 7-14 walked for 5 minutes wearing a face mask, reporting discomfort but no differences in respiratory and heart rates (Goh et al., 2019). Another randomized crossover study involving children aged 8-11 found complaints of heat and perceived difficulty breathing during 3 minutes of walking and running in the face mask group (Smart et al., 2020). In an additional study, it was reported that the use of masks negatively impacted both the duration of exercise and VO^2 max values (Driver et al.,2022). Recently, the WHO cautioned against mask usage during intense physical activity due to potential breathing discomfort (Hopkins et al., 2021). Concerns have also been raised regarding the potential for masks to impair oxygen intake during exercise and increase breathing resistance and carbon dioxide rebreathing (Chandrasekaran and Fernandes, 2020). However, other studies involving healthy individuals performing low- to moderate-intensity treadmill exercise for an hour while wearing a surgical face mask or an N95 filtering facepiece respirator revealed no physiological effects (Roberge et al., 2012). When studies on mask usage are examined, some reports indicate that they affect physical performance while others do not. It is observed that the literature on this subject is limited and does not have a consensus view.

We felt the necessity to conduct this study as we hypothesized that the continuous use of masks in daily life, especially among children, could negatively impact performance. It has been observed that during global crises, such as the COVID-19 pandemic, the use of masks becomes mandatory. The usage of masks is also reported to impose an additional burden on the respiratory system. We speculate that this added load on the respiratory system could adversely influence performance. Upon reviewing the literature, it is observed that there is a limited number of studies addressing the impact of surgical mask usage on physical abilities in children. The present study aims to evaluate the immediate effect of surgical masks on balance and mobility in elementary school children.

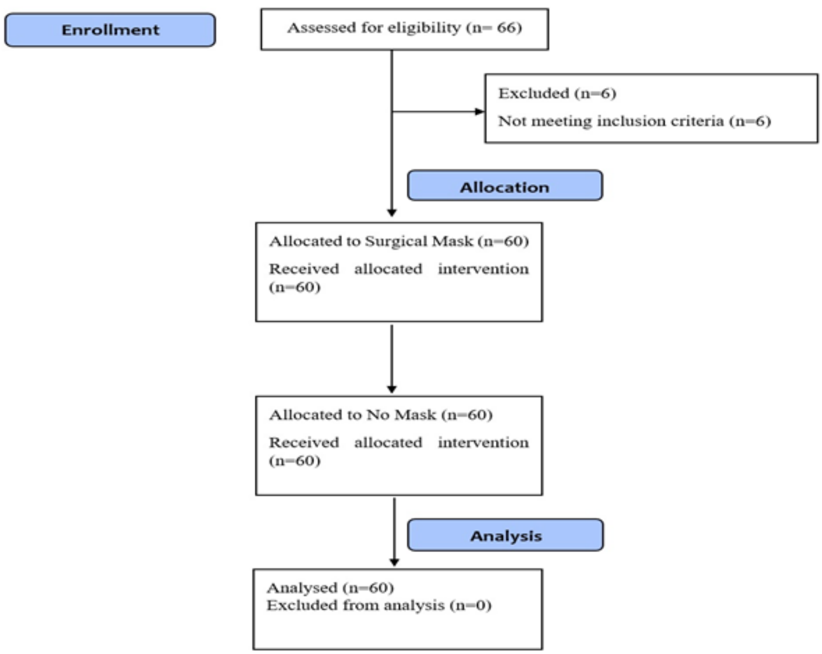
METHODS

Participants

This study was conducted between January and September 2022 at XXX college in XXX. The study included thirty-four male and twenty-six female primary school students, aged between 9 and 12. The study received approval from the Non-interventional Ethics Committee at İstanbul Medipol University (number: 1263, date:

17/12/2021) and was carried out in accordance with the principles of the Declaration of Helsinki. Inclusion criteria for participants were: ability to perform the 6-Minute Walk Test (6MWT), absence of cardiac-respiratory diseases, and daily use of a facemask at school. Exclusion criteria included having had COVID-19 within the past month and the presence of neurological or orthopedic diseases that could impair performance. For the study, written consent was obtained from the parents of the children. The study was completed with sixty children, and the algorithm for participant allocation is illustrated in Figure 1.

Fig 1. Flow chart of the participants



Instrumentation

All participants' demographic information was recorded. Body mass index was calculated [body weight (kg)/height (m^2)]. Outcome measures for all participants were evaluated both with and without a mask. Participants were blinded to all measurements. The primary outcomes of the study were the 6-minute walk test, the 30-second sit-to-stand test, and the single-leg stance test. Dyspnea, as assessed by the visual analog scale (VAS), was considered a secondary outcome. The 6MWT was conducted following the American Thoracic Society's recommendations. Children were instructed to walk as quickly as possible without running along a straight, 30-meter corridor for six minutes. Time was monitored using a stopwatch, and participants were encouraged to maintain their pace every minute. Upon completion, the six-minute walking distance (in meters) and self-perceived dyspnea (VAS) were measured. During the 6MWT, patients indicated their breathing ability on a scale of 0 to 10, with "0" representing "I could breathe properly" and "10" indicating "I could not breathe" (Keye et al., 2021). The six-minute walk test is typically employed to assess cardiovascular fitness. However, in our study, children were made to wear masks, introducing an additional load on the respiratory system. Therefore, the six-minute walk test was chosen in our study to evaluate the impact of this added respiratory load on performance. 30-second sit-to-stand test required participants to cross their hands over their shoulders while seated in an armless chair. A stopwatch was set for 30 seconds, and the participant was instructed to fully stand up and sit back down upon hearing the word "start." The number of completed repetitions was recorded (Aylar, 2017). The Single Leg Stance Test (SLST) assessed static balance. The trial with the lowest error out of three attempts, performed with eyes open, was reported. The error means posture changes in the attempts. Children were evaluated with their eyes open, standing on the dominant leg, maintaining leg separation, and holding a single-leg posture for as long as possible, up to 30 seconds. The number of posture changes during the session was noted as a score (Zumbrunn et al., 2011).

Procedure

Prior to the measurements, children received standardized instructions on completing the 6-minute walk test, 30-second sit-to-stand test, and single-leg stance test. Subsequently, participants performed two separate 6MWTs, a 30-second sit-to-stand test, and a single-leg stance test, both without a mask (NM) and with a surgical mask (SM). The SM used was a 3-Layer Disposable Surgical Face Mask. Participants first completed the evaluation tests without masks, then repeated the tests wearing surgical masks. Each participant also served as their own control group. A 15-minute rest period was provided between tests to minimize fatigue, and a 60-minute transition time was allotted between masked and unmasked tests. The experimenter's instructions were verbally reviewed for both masked and unmasked conditions during each test. Upon completion, the scores for both conditions were recorded.

Statistical Analyses

Data analyses SPSS (Statistical Package for Social Science) 25.0 for Windows was used for statistical analyses. The normal distribution of the variables was tested by the Kolmogorov-Smirnov Test. Paired sample t-test was used to compare masked and unmasked assessments. The significance value was accepted as $p<0.05$.

RESULTS

Table 1. Demographic characteristics of the participants

	Female (n=26)	Male (n=34)	Total (n=60)
Age (years)	11±0.85	11.15±0.88	11.06±0.86
BMI (kg/m^2)	24.0±4.4	26.0±3.9	25.0±4.4

BMI: Body mass index

This study recruited 60 healthy children, 26 female and 34 male participants. The average age of the participants was 11.06±0.86 (Table 1).

Table 2. Comparison of the evaluation results of SM and NM conditions

Outcome Measurement	SM Condition (mean±sd)	NM Condition (mean±sd)	p
6 MWT (meter)	540.96±69.90	575.33±71.44	**<0.01**
30-sec sit to stand test (sec)	22.26±8.72	25.70±8.86	**<0.01**
Single leg stance test	1.60±1.63	1.23±1.55	**0.055**
Dyspnea-VAS	3.63±1.02	1.73±0.73	**<0.01**

Upon comparing the results of the 6-Minute Walk Test (6MWT) (SM: 540.96 ± 69.90, NM: 575.33 ± 71.44, $p<0.01$) and the 30-Second Sit-to-Stand Test (SM: 22.26 ± 8.72, NM: 25.70 ± 8.86, $p<0.01$) between the no-mask (NM) and surgical-mask (SM) conditions, a statistically significant difference was observed. In the Single Leg Stance Test, values increased under the NM condition; however, no significant difference was found between the NM and SM conditions ($p>0.05$). Furthermore, the Rating of Perceived Dyspnea values for the SM condition were notably higher than those in the test without a mask ($p<0.05$) (Table 2).

DISCUSSION

In the current study investigating the effects of surgical face masks on the 6-Minute Walk Test (6MWT), 30-second sit-to-stand test, and single leg stance test in elementary school children, we observed no significant difference in the single leg stance test with or without a mask. However, we did note a substantial increase in dyspnea (as measured by the Visual Analog Scale), a decrease in the distance walked, and a decline in the 30-second sit-to-stand performance when wearing a mask. A review of existing literature reveals ambiguity regarding the potential health hazards of wearing a mask while engaging in physical activity. Moreover, most research focuses on the effects of wearing masks during exercise. To our knowledge, limited number of studies have specifically investigated the impact of wearing masks on mobility, functional capacity, and balance assessments in children. In a relevant study, the influence of mask-wearing on respiration and physiological variables was examined in patients with renal failure, revealing that wearing an N95 mask for four hours during hemodialysis significantly reduced arterial oxygen partial pressure (Kao et al., 2004). Another study reported that N95 masks impede respiration and gas exchange in healthcare workers, imposing an additional metabolic workload (Tong et al., 2015). Researchers also observed clinically and statistically significant differences in dyspnea scores when wearing a surgical mask (NCIRD, 2020). In line with these findings, our study demonstrated that mobility and functional exercise capacity assessments were negatively affected by mask usage. It is well-documented that mask usage during activity reduces oxygen levels and increases CO_2 levels (Pifarré et al., 2020), which may explain the adverse effects on the 6MWT and 30-second sit-to-stand test results. According to Fikenzer et al., surgical face masks significantly reduce cardiopulmonary capacity, detrimentally impacting physical activity. Both maximum power output and maximum oxygen uptake (VO_2max/kg) during exercise are considerably reduced by all masks (Fikenzer et al., 2020). The primary influence of face masks on healthy individuals' physical performance is attributed to the decrease in pulmonary function. Additionally, auxiliary breathing muscles have been reported to generate extra afferent drive, potentially exacerbating fatigue (Amann et al., 2009). Children wearing face masks experience greater fatigue and discomfort than adults, which may account for the observed decline in the 6MWT and 30-second sit-to-stand test performance in our study.

Contrarily, some studies suggest that mask-wearing does not cause significant changes in oxygen and carbon dioxide levels during rest or sedentary activity (Rebmann et al., 2013), nor does it affect heart rate, muscle oxygenation, or oxygen saturation during exercise in adults (Shaw et al., 2020). Shaw et al. (2020) and Epstein et al. (2021) examined the effects of mask-wearing during maximal exercise, finding no significant differences in heart rate, blood pressure, perceived dyspnea, or oxygen consumption between masked and unmasked conditions. However, these studies were conducted on healthy adults, with limited research exploring the potential adverse effects of mask usage in children.

In our study, 6MWT and 30-second sit-to-stand test results for children were statistically better without masks. This discrepancy could be attributed to psychological factors associated with mask-wearing and differences in respiratory physiology between children and adults. Fikenzer et al. (2020) also reported heightened discomfort when wearing a mask compared to unmasked conditions. Factors contributing to this discomfort include the mask's tight seal, increased breathing resistance, and elevated heat accumulation. We hypothesize that the discomfort caused by masks affects children's mobility. Furthermore, our study evaluating static balance revealed that the mask might not have impacted static balance due to the children's proficient balance function. The study's design could have been im-

https://doi.org/10.17155/omuspd.1287395

proved as a randomized controlled crossover trial, which we plan to implement in future research. Limitations of our study include performing the test conditions on the same day, even with a rest period between masked and unmasked tests and using only a single leg stance test to evaluate balance.

Our findings suggest that wearing surgical face masks negatively affects mobility and functional exercise capacity assessments in elementary school children, particularly in the 6MWT and the 30-second sit-to-stand test. In our study, the respiratory workload of children was increased by enforcing mask usage. Restrictions in functional movements were observed even after short-term use of masks. Especially in situations where mask usage is mandatory, such as during the Covid-19 pandemic, it has been demonstrated that mask usage reduces performance parameters. In addition to our study investigating the short-term effects of mask usage in children, we hypothesize that long-term effects of mask usage could potentially negatively impact mobility.

CONCLUSION

No significant difference was observed in the single leg stance test. Further research is needed to elucidate the specific factors contributing to these effects, particularly in children, and to explore potential differences in respiratory physiology compared to adults. Moreover, future studies could benefit from a randomized controlled crossover trial design and additional methods for evaluating balance. Ultimately, understanding the impact of mask-wearing on physical performance in children is essential to informing recommendations and guidelines for mask usage during physical activities in this population. Our study demonstrated that wearing a mask increases discomfort and adversely impacts mobility during test conditions.

Conflict of Interest Statement

The authors declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Author Contribution Rates

Design of Study: BM(%60), MYM(%40)

Data Acquisition: BM(%50) MYM(%50)

Data Analysis: MYM(%100)

Writing Up: BM(%100)

Submission and Revision: BM(%50) MYM(%50)

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