

Asthma Control, Sleep Quality and Physical Activity among Patients with Asthma in Colombo, Sri Lanka

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ASTHMA CONTROL, SLEEP QUALITY AND PHYSICAL ACTIVITY AMONG PATIENTS WITH ASTHMA IN COLOMBO, SRI LANKA

Abstract: Global asthma network has Sri Lanka marked as one of the highest prevalence countries. Physical activity and quality sleep has been shown to produce health benefits to adults with asthma; however, the association between physical activity, sleep quality and asthma control is unknown. The aims of the study were to determine: the level of asthma control, physical activity, sleep quality and its associations amongst adults with asthma. A descriptive cross-sectional study was conducted among 180 patients diagnosed with asthma attending to chest clinics at Colombo South Teaching Hospital (CSTH) and Base Hospital, Homagama. An interviewer administered questionnaire was used to determine baseline data. Asthma control was assessed using Asthma Control Test and lung function tests (spirometry/PEFR). Airway inflammation was measured using Fraction of exhaled NO analyzer (FeNO). Sleep quality was determined by using the Pittsburg Sleeping Quality Index and physical activity level was determined by the International Physical Activity Questionnaire. 60% were females. The mean PEFR, FEV1, FVC, FEV1/FVC and FeNO were 192.54 ± 78.50 L/min, 1.42 ± 0.51 L, 2.07 ± 0.56 L, $0.67 \pm 0.14\%$, 18.47 ± 16.01 ppb. only 33.33% had controlled asthma. ACT scores of males was significantly higher than of females ($p = 0.035$). 64.4% of patients had deficient sleep quality. The level of Physical activity was moderate at 43.33% and low at 38.89%. Although there was a significant association between sleep quality and asthma control ($p = 0.000$) and it was a positive correlation ($p = 0.000$). Physical activity is also significantly associated with asthma control ($p = 0.001$). It was a positive correlation between ($p = 0.030$) them. There was an association between sleep quality, physical activity and asthma control. Sleep quality is a marker of asthma control and affects the health status of asthma patients. Physical activity is a possible protective factor against the development of episodes of asthma.

Keywords: Adults, Asthma, Physical activity, Sleep quality

Introduction

“Asthma is a disease characterized by recurrent attacks of breathlessness and wheezing, which vary in severity and frequency from person to person” (WHO 2018). During an attack of asthma, bronchoconstriction, mucosal oedema and inflammation causing the airways to narrow and reduce the flow of air in and out of the lungs (WHO 2018). The most common symptoms of asthma are wheeze, shortness of breath, chest tightness and cough (GINA 2018). 1-18% of the population in different countries worldwide is affected by asthma (GINA 2018). Globally, asthma is ranked sixteenth among the leading causes of years lived with disability and twenty-sixth among the leading cause of burden of disease (GAR 2018). In Asia asthma is substantial, but it remains undertreated. In Sri Lanka, 2.5 number of deaths per 100 000 population is due to asthma and a higher prevalence of asthma can be observed among adults rather than children (AHS 2016). The number of asthma attacks, mortality rate and hospitalizations help to determine the negative impact of asthma. However, the effects of asthma can impair the life quality of patients (Gazotti *et al.*, 2013). So, asthma is a huge health problem and burning problem in Sri Lanka today (Amarasiri *et al.*, 2016) Asthma patients are classified as having their disease symptoms controlled, partially controlled, or uncontrolled. It is classified using the basis of symptoms, limitations in activities of daily living, nocturnal awakenings, use of rescue medication, and pulmonary function (Gazotti *et al.*, 2013). Therefore, it is important to know what impact asthma has on subjects affected by the disease and what is their level of asthma control (Gazotti *et al.*, 2013).

Physical activity level is another measurement of quality of life and asthma control among asthmatics. Among adults, asthma impairs activities of daily living (ADLs) and reduces levels of activity (Wood *et al.*, 2017). Restrictions in activity can negatively affect day-to-day life. Delaying the onset of these limitations in older patients with asthma may improve the quality of life and physical fitness (Wood *et al.* 2017). Physical activity positively leads to the patency of bronchioles: poor mucociliary clearance from decreased epithelial stimulation secondary to decreased activity can cause excess mucus and airway edema (Eijkeman, 2012). Decreased deep inspiration and sigh rate during physical inactivity

could lead to smooth muscle latching and subsequent increased risk of asthmatic symptoms (Eijkeman, 2012)

Nevertheless, regular physical activity is an important component of asthma management. Physical activity has also been associated with a decrease in the severity of the symptoms of asthma and an improvement in the quality of life among adults with asthma (Vermeulin *et al.*, 2016). Therefore, it's important to know the relationship between asthma control and physical activity as it can potentially aid health care providers when counseling adults on asthma self-management.

Challenges faced in Healthcare Access

Despite the specific health challenges that some MWs may face, a few barriers to healthcare access remain. In a survey of senior doctors in Singapore, the most common perceived barriers to MWs accessing healthcare were related to culture, language, and finances (Ang *et al.*, 2020). Despite the need for employers to provide MWs with \$60,000 of insurance each policy year (Ministry of Manpower, 2024), some workers still thought that they had no insurance, or were expected to pay for healthcare support entirely out of their own pocket (Ang *et al.*, 2017).

Some MWs do not have outpatient costs covered by their insurance and may not be able to afford outpatient fees. This, along with fear of being repatriated in the event of a diagnosis of illness, causes a small minority MWs to avoid obtaining treatment for acute and chronic conditions. For instance, a survey of 525 male MWs found that 17% of MWs refrained from notifying their supervisor of a serious work-related injury, and 12% refrained from seeing a doctor despite running a high fever with prolonged respiratory symptoms (Lee *et al.*, 2014).

Methodology

A descriptive cross-sectional study was conducted among 180 adults with asthma attending two selected respiratory clinics in Colombo, Sri Lanka. The consecutive sampling method is used. Patients with acute episodes of asthma, patients with acute episodes with secondary infection (presently on antibiotics) and patients with other comorbidities such as diabetes and hypertension are excluded. Baseline data were obtained by an interviewer administered questionnaire. Asthma control was determined using a validated Asthma Control Test (ACT) and lung functions tests. The test used to detect how well the patients' asthma has been controlled over the last four weeks. This test is suitable for asthma patients aged 12 years and over. There were 5 questions and give score out of 25. They rate overall asthma control as ≤ 15 uncontrolled, 16-19 partially controlled, 20-24 controlled and 25 completely controlled (Kosinski *et al.*, 2008). Lung function tests play an imperative role in describing lung dysfunction, assessing the severity and diagnosis of obstructive, restrictive and occupational lung diseases, and establishing prognosis. Lung function was measured using a daily calibrated spirometer using a 3L calibration syringe. The subject was made aware of the procedure clearly with demonstrations by a familiarized technician. Spirometry measurements were Forced Vital Capacity (FVC) and Forced Expiratory Volume in one second (FEV1). PEFR was measured with mini wright compatible peak flow meter. The exhaled nitric oxide levels are a very good indicator to identify airway inflammation and used to determine the severity of the disease of asthmatic patients. Fractions of exhaled Nitric Oxide Levels were measured according to the latest American Thoracic Society/European Respiratory Society recommendations. The physical activity levels were determined using a validated International Physical Activity Questionnaire (IPAQ) (Ashok *et al.*, 2017). The questionnaire includes a set of 4 questionnaires. The questions were asked about the time spent being physically active in the last 7 days (Ashok *et al.*, 2017). Metabolic Equivalent of Task (MET) was calculated by IPAQ evaluation as follows: MET values and formula for computation of MET-minutes/week. After calculation of the total MET score, the participants were divided into 3 categories as follows: <600 MET-minutes/week – low physical activity, ≥ 600 to <3000 MET-minutes/week – moderate physical activity and ≥ 3000 MET minutes/week-

high physical activity. Height and weight were measured using a stadiometer and an electronic portable bathroom scale with an accuracy of 0.1 kg.

The data was analyzed using statistical Package for social sciences (SPSS) software version 25. The data were presented by using graphs and charts. Categorical variables were depicted as numbers, percentages and continued variables we represented as means and standard deviations. Frequency of socio demographic Characteristics, types of asthma medication, type of inhaler they used were analyzed by using descriptive statistics. An independent sample t-test was used when comparing means for continuous variables such as anthropometric measurements (weight, height, BMI) and Respiratory function measurements (PEFR, FeNO, spirometry measurements) according to the gender distribution and level of physical activity. The Chi square test for independence was used to explore the relationship between two categorical variables. It is based on a crosstabulation table. Association between gender and asthma control, association between asthma control and physical activity level crosstabulation was done using this test. Pearson Chi Square test values were taken to interpret the results. To describe the strength and direction of the linear relationship between two variables was used correlation analysis. The relationship between asthma control and physical activity level was investigated using correlation coefficient. Ethical clearance was obtained from the Ethics review committee of Faculty of Medical Sciences, University of Sri Jayewardenepura, Nugegoda. Permission to carry out the study at Colombo South Teaching Hospital was obtained from the Ethics Review Committee of CSTH, Kalubowila. The permission to carry out the study at base hospital, Homagama was obtained from the director of the hospital.

Results and Discussion

Out of the 180 patients included in this study, 60% of patients were females. 40% of patients were above 50 years. Majority of asthma patients (83.9%) were Sinhalese and 91.1% were married. In this study group only 34.4% of patients had a family history of asthma. There were 10% smokers, 9.4% alcohol users and 14.4% beetle chewing people. 10.6% of asthma patients were affected with the disease for more than >20 years. The mean BMI of the female asthma patients was higher than the male asthma patients ($p=0.933$) (Table 1). Most asthma patients were users of inhalers, 56.7% of the population of the study were treated with inhalers. 70% used short acting beta 2 agonist as their inhaled drug. Most of the asthmatics (94.4%) attended the clinic every month (Table 2).

Table 1: Baseline characteristics of the study population

Baseline Characteristics Frequency n (%)	
Gender	
Female	108(60.0)
Male	72(40.0)
Age	
18-29 years	7(3.9)
30-49 years	29(16.1)
50-64 years	72(40.0)
above 65 years	72(40.0)
Ethnicity	
Sinhala	151(83.9)
Tamil	15(8.3)
Muslim	10(5.6)

Burgher	4(2.2)
Marital Status	
Single	16(8.9)
Married	164(91.1)
Occupation	
Professional	5(2.8)
Technical and clerical	10(5.6)
Vendors and sellers	7(3.9)
Skilled manual workers	21(11.7)
Unskilled manual workers	10(5.6)
Retired	39(21.7)
Unemployed	71(39.4)
Self-employed	17(9.4)
Family history of Asthma	
Yes	62(34.4)
No	118(65.6)
Personal habits	
Smoking	18(10)
Use of alcohol	17(9.4)
Beetle chewing	26(14.4)
Duration of Asthma	
<1 year	38(21.1)
2-5 years	66(36.7)
6-1 years	30(16.7)
11-20 years	27(15)
>20 years	19(10.6)

Table 2: Current treatment for asthma among asthma patients

Treatment for asthma	Frequency (%)
Type of current treatment	
Only Oral	7(3.9)
Only Inhalers	102(56.7)
Both	71(39.4)
Type of current oral medication	
Salbutamol	11(6.1)
Theophylline	67(37.2)
Prednisolone	6(3.3)
Antihistamines	55(30.6)

Type of the inhaler	
Long acting beta 2 agonist	5(2.8)
Short acting beta 2 agonist	126(70)
Leukotriene modifiers	0(0)
Inhaled corticosteroids	95(52.8)
Combine therapy	55(30.6)
Frequency of clinic visits	
Once a month	170(94.4)
Twice a month	6(3.3)
More than twice a month	4(2.2)

There was a significant difference between gender and FEV1/FVC value ($p=0.035$). And, no significant differences were found between gender and PEFr, FeNO and other spirometry values ($p>0.05$) (Table 3).

Asthma control of the group of asthma patients was assessed by using ACT questionnaire. According to the ACT scores, mean ACT score was 17.31 ± 3.32 . Only 33.33% of patients had controlled asthma and there were no patients who reported that their asthma was completely controlled. Among controlled population, majority of patients (17.78%) were male patients. Asthma was partially controlled in 37.78% of participants and uncontrolled in 28.89% of participants. There was a significant difference between gender and ACT scores, indicating that more female patients had uncontrolled or poorly controlled asthma when compared to male patients [Figure 1, ($\chi^2=6.68$, $df=2$, p value= 0.035)].

Table 3: Respiratory function according to gender distribution among asthma patients

Gender			
Lung function	Male (n=72)	Female(n=108)	p value
Measurements	Mean $\pm$ SD	Mean $\pm$ SD	
PEFR (L/min)	192.54 $\pm$ 78.50	194.92 $\pm$ 97.36	0.228
FEV1 (L)	1.42 $\pm$ 0.51	1.35 $\pm$ 0.47	0.121
FVC (L)	2.07 $\pm$ 0.56	1.80 $\pm$ 0.59	0.858
FEV1/FVC (%)	0.67 $\pm$ 0.14	0.75 $\pm$ 0.12	0.035
FeNO (ppb)	18.47 $\pm$ 16.01	19.78 $\pm$ 13.30	0.339

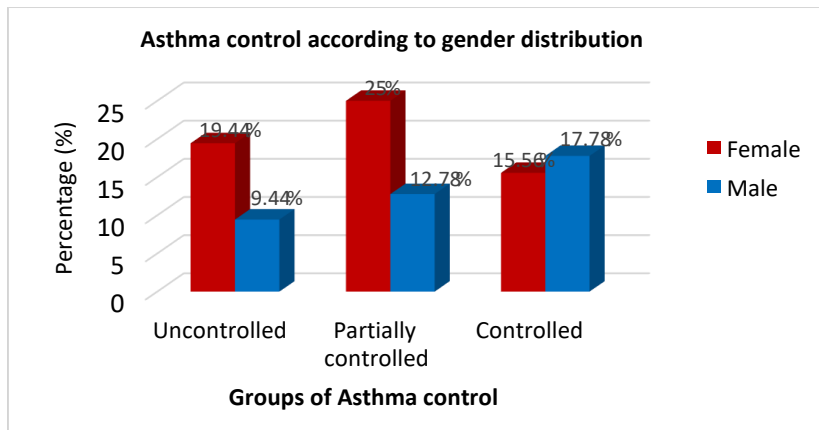


Figure 1: Asthma control according to the gender distribution

IPAQ is used as the validated instrument to measure the physical activity level in asthma patients. After calculation of MET minutes/week, the mean score of physical activity level was 2318.70 ± 507.7 . Majority of patients had moderate (43.33%) and low (38.89%) physical activity. There was no significant difference between gender and physical activity level amongst the males and females in this study [Figure 2, ($\chi^2=1.81$, $df=2$, P value=0.404)].

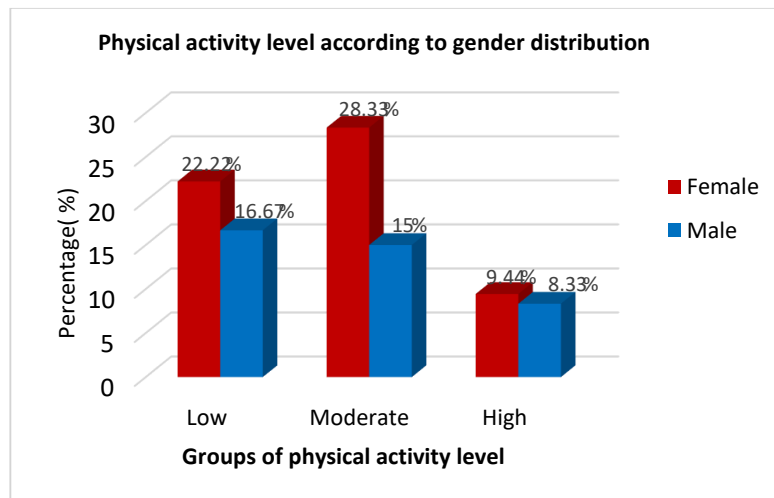


Figure 2: Physical activity level according to gender distribution among asthma patients

Majority of the patients in the controlled group had low physical activity level (14.4%). Although there was a significant difference between physical activity level and asthma control [Table 4, ($\chi^2=18.67$, $df=4$, $p=0.001$)]. According to correlation analysis, the research study found a positive correlation between physical activity and asthma control among the asthma patients ($r_s = 0.162$, $p=0.030$).

Table 4: Physical activity level according to asthma control among asthma patients

Asthma control				
Physical activity level value	Uncontrolled	Partially controlled	Controlled	p
Low	27(15%)	16(8.9%)	26(14.4%)	0.001
Moderate	22(12.2%)	38(21.1%)	18(10%)	
High	3(1.7%)	14(7.8%)	16(8.9%)	

This cross-sectional study was conducted to determine asthma control and level of physical activity of patients diagnosed with asthma in two selected hospitals in Colombo district. Asthma control and physical activity level were assessed by using Asthma Control Test and International Physical Activity Questionnaire. The present study examined 180 asthma patients and there was high prevalence of asthma among females (60%) than males (40%). The prevalence of asthma in this study similarly to the study reported by Amarasiri and team (Amarasiri *et al.*, 2016). And, the prevalence of asthma in Sri Lankan adults is high in comparison with global data (Amarasiri *et al.*, 2016). Majority of asthma patients attending the clinic were within an age range of over 50 years (80%). Similarly, another research study done in Sri Lanka indicated that the prevalence of asthma was higher in adults aged >45 years (Amarasiri *et al.*, 2016). Perhaps this may be due to the exposure to the risk factors during a long period. In the present study only a few asthma patients were within the age group of 18-29 years, 3.9% and 16.1% were within the age group of 30-49 years. This may be due to these patients of the above age range falling within the working population and thus were unable to take leave to attend the hospital clinics. Majority of patients were married, and they belong to the major ethnic group Sinhalese. In this study most of the asthma patients were unemployed and retired patients (61.1%). Family history of asthma or allergy increases the probability that respiratory symptoms are due to asthma. In this study, there were 34.4% of patients with family history of asthma. This may indicate that other factors other than genetic predisposition may contribute to asthma in this population (GINA 2018). There were 10% smokers, 9.4% alcohol users and 14.4% betel chewing people. As per data from other countries, asthma patients in Sri Lanka too are substance abusers a majority of 10% were smokers despite their asthma (Amarasiri *et al.*, 2016). Approximately similar percentages (12.2%) of smokers were reported by (Amarasiri *et al.*, 2016). Most of the asthma patients had a long history of the disease, 36.7%, had duration of asthma of 2-5 years. 10.6% of asthma patients were affected with the disease for more than >20 years. This indicates that asthma control is poor amongst the patients attending the clinics. Further it indicates the burden of health care costs for the Sri Lankan government. Poor asthma control demands increased medications and health care. All health care in government hospitals is provided free of charge to patients in Sri Lanka. Most asthma patients were users of inhalers, (56.7%). 70% of patients used short acting beta 2 agonist as their inhaled drug. Some studies revealed that using combination treatment provided significantly greater improvement in pulmonary functions (Sundbom *et al.*, 2019). And also, in this study, most of them had regular follow up (94.4%) but very few of them attended did not attend the follow up clinics regularly. However, 2.2% were reviewed at the clinic more than twice a month, indicating poor asthma control. There was no significant difference between gender, weight and BMI of the study group ($p>0.05$). However as expected there was a significant difference between the height of the male and female asthma patients ($p = 0.04$). The mean BMI of sample was 24.5Kg/m² and BMI findings of the study similar (Mean BMI - 23.1Kg/m²) to the present study was done by (Choi *et al.*, 2017). In this study, the mean BMI value of the female asthma patients was higher than the male asthma patients ($p=0.933$). Analyzed results revealed that there was a significant difference between gender and FEV1/FVC ($p=0.035$). However, there were no significant differences between gender and PEFR, FeNO and other spirometry values. Asthma control is an indicator of quality of life. It refers to the degree to which asthma symptoms are minimized by current treatment and is the basis for asthma management and treatment decisions (GINA 2018). In the present study, asthma control was divided

into four groups. Uncontrolled (≤ 15), partially controlled (16-19), controlled (20-24) and completely controlled (20) are these four groups. 33.33% of asthma patients. Overall asthma control seemed to be unsatisfactory in the majority, as 67% of the sample did not achieve good 55 control according to the ACT. Perhaps this may be due to poor involvement of patients in their disease, poor drug adherence, exposure to asthma triggers and deficient sleep. There was a significant difference between gender and ACT scores ($\chi^2=6.68$, $p=0.035$). In contrast, a research study had done in Brazil found no significant differences in gender when the asthma control was compared between males and females (Matsunaga *et al.* 2017). Similar to the above study, and the study by Sundberg *et al.* (2010) too found no gender differences in asthma control. However, the present study had a gender difference in asthma control with more females having poorly controlled asthma than males. This study explored that higher proportion of asthma patients were engaged in moderate physical activity. Most of them did not engage in vigorous physical activities within the last week. They were engaged in moderate physical activities and walking within the last week. And also, most of them spent time sitting during the last week. In this study, there was no significant difference between gender and physical activity level. Similarly, Jerning *et al.* (2013) reported no significant difference between gender and physical activity level.

There was a significant difference between physical activity level and asthma control ($\chi^2=18.67$, $df=4$, $p=0.001$). There was a positive correlation between physical activity and asthma control ($r_s = 0.162$, $p=0.030$). In general, these findings were in line with the study done in Canada (Bacon *et al.*, 2015). The patients with asthma were less physically active and they engaged in few vigorous physical activities. In contrast, Matsunaga *et al.* (2017) showed that there was no association between physical activity level and asthma control. Increased levels of physical activity has been linked to improving the health and health outcomes across a variety of chronic diseases, like asthma (Bacon *et al.*, 2015). In addition to that there was a positive correlation between asthma control and physical activity level. Physical activity is a possible protective factor against asthma development. The patients reported with uncontrolled asthma more likely to have limitations in physical activity. To achieve an appropriate level of physical activity improvement of asthma control is considered as important. There was a significant difference between FEV1/FVC and gender. The findings highlighted that awareness of this association, and its clinical implications could lead to good asthma control and manage their physical activity level.

Conclusion & recommendations

Higher physical activity levels might contribute to better asthma control and should be encouraged in asthma patients. Most Sri Lankan patients do not engage in regular physical activity and in most cases cultural beliefs and family members inhibit a patient from engaging in regular physical activity. However, studies have revealed that regular physical activity enhances asthma control and these patients should be motivated by health care personnel, during their clinic visits, to engage in regular physical activity. Patients should be motivated by health care personnel, during their clinic visits, to engage in regular physical activity. Education programs for patients should be organized to improve asthma control and physical activity level. It is need to improve knowledge of management among health care professionals to provide better care for asthma patients attending the clinics.

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References

- Ang, J.W., Chia, C., Koh, C.J., Chua, B.W.B., Narayanaswamy, S., Wijaya, L., Chan, L.G., Goh, W.L. and Vasoo, S. (2017) 'Healthcare-seeking behaviour, barriers and mental health of non-domestic migrant workers in Singapore', *BMJ Global Health*, 2(2), e000213. Available at: <https://doi.org/10.1136/bmjgh-2016-000213>
- Ang, J.W., Koh, C.J., Chua, B.W., Narayanaswamy, S., Wijaya, L., Chan, L.G., Soh, L.L., Goh, W.L. and Vasoo, S. (2020) 'Are migrant workers in Singapore receiving adequate healthcare? A survey of doctors working in public tertiary healthcare institutions', *Singapore Medical Journal*, 61(10), pp. 540–547. Available at: <https://doi.org/10.11622/smedj.2019101>
- Chairani, A. (2020) 'Validity and reliability test of the Nordic musculoskeletal questionnaire with formal and informal sector workers', *7th International Conference on Public Health 2020*, Surakarta, Indonesia, November 2020. Sebelas Maret University, pp. 100–106. Available at: <https://doi.org/10.26911/the7thicph-FP.05.06>
- Cooper, G.C., Harvie, M.N. and French, D.P. (2017) 'Do negative screening test results cause false reassurance? A systematic review', *British Journal of Health Psychology*, 22(4), pp. 958–977. Available at: <https://doi.org/10.1111/bjhp.12265>
- Da Costa, B.R. and Vieira, E.R. (2010) 'Risk factors for work-related musculoskeletal disorders: A systematic review of recent longitudinal studies', *American Journal of Industrial Medicine*, 53(3), pp. 285–323. Available at: <https://doi.org/10.1002/ajim.20750>
- Farwin, A., Low, A., Howard, N. and Yi, H. (2023) "'My young life, finished already?": A qualitative study of embedded social stressors and their effects on mental health of low-wage male migrant workers in Singapore', *Globalization and Health*, 19(1). Available at: <https://doi.org/10.1186/s12992-023-00946-5>
- Goh, D.P. and Lee, A. (2022) 'Migrant worker recreational centres, accidental diversities and new relationalities in Singapore', *Urban Studies*, 59(16), pp. 3312–3329. Available at: <https://doi.org/10.1177/00420980221081336>
- Hasan, S.I., Yee, A., Rinaldi, A., Azham, A.A., Mohd Hairi, F. and Amer Nordin, A.S. (2021) 'Prevalence of common mental health issues among migrant workers: A systematic review and meta-analysis', *PLOS ONE*, 16(12). Available at: <https://doi.org/10.1371/journal.pone.0260221>
- Kahar, P. and Negroni, L.K. (2020) 'Results from brief educational intervention and health screenings: A community health study of Latinos in Southwest Florida', *Journal of Education and Health Promotion*, 9, p. 148. Available at: https://doi.org/10.4103/jehp.jehp_157_20
- Leavell, H.R. and Clark, E.G. (1979) *Preventive Medicine for the Doctor in His Community: An Epidemiologic Approach*.
- Lee, W., Neo, A., Tan, S., Cook, A.R., Wong, M.L., Tan, J., Sayampanathan, A., Lim, D., Tang, S.Y., Goh, W.L., Chen, M.I. and Ho, C. (2014) 'Health-seeking behaviour of male foreign migrant workers living in a dormitory in Singapore', *BMC Health Services Research*, 14, p. 300. Available at: <https://doi.org/10.1186/1472-6963-14-300>

- McKeirnan, K.C., Panther, S.G. and Akers, J.M. (2015) 'Redesigning the traditional community health screening model to provide blood glucose screening and interdisciplinary health education', *Clinical Diabetes: A Publication of the American Diabetes Association*, 33(4), pp. 189–192. Available at: <https://doi.org/10.2337/diaclin.33.4.189>
- Melo, I.M.M. *et al.*, (2022) 'Accuracy of smartphone-based hearing screening tests: A systematic review', *CoDAS*, 34(3). Available at: <https://doi.org/10.1590/2317-1782/20212020380>
- Ministry of Manpower (2021) *A Guide for Migrant Workers*. Available at: <https://www.mom.gov.sg/-/media/mom/documents/publications/mw-guides/mw-handly-guide-english.pdf>
- Ministry of Manpower Singapore (2024) 'Medical insurance requirements for migrant workers', *Ministry of Manpower Singapore*. Available at: <https://www.mom.gov.sg/passes-and-permits/work-permit-for-foreign-worker/sector-specific-rules/medical-insurance>
- Naz, H., Nijhawan, R. and Ahuja, N.J. (2024) 'Clinical utility of handheld fundus and smartphone-based camera for monitoring diabetic retinal diseases: A review study', *International Ophthalmology*, 44(41). Available at: <https://doi.org/10.1007/s10792-024-02975-4>
- Nystoriak, M.A. and Bhatnagar, A. (2018) 'Cardiovascular effects and benefits of exercise', *Frontiers in Cardiovascular Medicine*, 5, p. 135. Available at: <https://doi.org/10.3389/fcvm.2018.00135>
- Ong, V.Y., Habibah, A.K. and Lee, F.C. (2006) 'Safety among foreign workers and impact on emergency medicine services in Singapore', *Singapore Medical Journal*, 47(2), pp. 121–128.
- Rajaraman, N., Yip, T.-W., Kuan, B.Y. and Lim, J.F. (2020) 'Exclusion of migrant workers from national UHC systems—perspectives from HealthServe, a non-profit organisation in Singapore', *Asian Bioethics Review*, 12(3), pp. 363–374. Available at: <https://doi.org/10.1007/s41649-020-00138-y>
- Sadarangani, S.P., Lim, P.L. and Vasoo, S. (2017) 'Infectious diseases and migrant worker health in Singapore: a receiving country's perspective', *Journal of Travel Medicine*, 24(4). Available at: <https://doi.org/10.1093/jtm/tax014>
- Seah, B.Z., Horie, S., Gan, W.H., Nagano, C., Tan, A.K., Mori, K. and Koh, D.S. (2024) 'A comparison of periodic health examinations and workplace health screening for workers in Singapore and Japan', *Industrial Health*. Available at: <https://doi.org/10.2486/indhealth.2024-0046>
- Shah, N., Cader, M., Andrews, W.P. *et al.* (2018) 'Responsiveness of the Short Warwick Edinburgh Mental Well-Being Scale (SWEMWBS): evaluating a clinical sample', *Health and Quality of Life Outcomes*, 16, p. 239. Available at: <https://doi.org/10.1186/s12955-018-1060-2>
- Soares, C.O. *et al.* (2020) 'Preventive factors against work-related musculoskeletal disorders: Narrative review', *Revista Brasileira de Medicina do Trabalho*, 17(3), pp. 415–430. Available at: <https://doi.org/10.5327/Z1679443520190360>
- Sotos-Prieto, M., Bhupathiraju, S.N., Mattei, J., Fung, T.T., Li, Y., Pan, A., Willett, W.C., Rimm, E.B. and Hu, F.B. (2017) 'Association of changes in diet quality with total and cause-specific mortality', *New England Journal of Medicine*, 377, pp. 143–153. Available at: <https://doi.org/10.1056/NEJMoa1613502>
- Tiwari, R., Banerjee, M., Kamath, R. and Nair, N.S. (2015) 'Dermatological and respiratory problems in migrant construction workers of Udupi, Karnataka', *Indian Journal of Occupational and Environmental Medicine*, 19(3), p. 125. Available at: <https://doi.org/10.4103/0019-5278.174001>

Transient Workers Count Too (2021) 'On average, Indian and Bangladeshi migrant workers stay 4.2 years with the same employer, our survey finds', TWC2. Available at: <https://twc2.org.sg/2021/10/18/on-average-indian-and-bangladeshi-migrant-workers-stay-4-2-years-with-the-same-employer-our-survey-finds/>

Urban Redevelopment Authority, Singapore Government (2019) *The Planning Act - Master Plan Written Statement 2019*. Available at: <https://www.ur.gov.sg/-/media/Corporate/Planning/Master-Plan/MP19writtenstatement.pdf>