INT. J. BIOL. BIOTECH., 18 (3): 537-546, 2021.

EXPLORING THE AWARENESS OF ASTHMA IN THE CONTEXT OF SOCIO-ECONOMIC DISPARITIES: A CASE STUDY OF KARACHI – PAKISTAN

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ABSTRACT

Although the host factors and the physical environment are known to be associated with high rates of asthma prevalence in urban settings, but the connection between asthma and level of awareness due to socio-economic conditions are still less explored. Especially in developing world where the contrast between rich and poor is humongous, available health facilities are overburdened, and literacy is still a question mark for learning and acquiring knowledge to boost the awareness about health issues. This paper aims to address gaps in scientific knowledge about the societal attitude towards environmental asthma-related risk in a megacity of a developing country. Data was collected with a 0.1% sample of households (n=1388) through a questionnaire from selected neighborhoods. Awareness about asthma diagnosis, treatment, emergency management and prevention were assessed through a 10-point Likert scale. Data was summarized for the assessment of collective knowledge. Correlation of cumulative awareness was calculated with asthma prevalence and socio-economic conditions. We found very low (4.5 out of 10) cumulative asthma awareness with 8% prevalence. Literacy stood out at the top having a strong relationship with cumulative asthma awareness. We found that a low level of literacy provokes more involvement in unhealthy occupation and careless behavior about asthma triggers. As a result, asthma prevalence is higher in people associated with unhealthy occupation and have a low level of awareness without proper health and safety measures. Findings has established the impact of socio-economic status on asthma awareness in two towns of Karachi. Though socioeconomic development of an area is a long journey, especially in developing countries, awareness programs can, however, make better public health in a short time. This strategy will also reduce the level of Covid-19 severity as asthma is considered one of the risk factors.

Keywords: Asthma, awareness, prevalence, public health, developing countries, Karachi

INTRODUCTION

Asthma leads to bronchoconstriction, plasma exudation, mucus hypersecretion and sensory nerve activation (Murphy and O'Byrne, 2010). It is known that people with asthma are at more severe risk of common cold virus infection than non-asthmatics (Corne *et el*, 2002). Similarly, the literature on Covid-19 explains the increased severity of asthmatics (Johnston, 2020; Pennington, 2020). The high level of interaction between environmental and genetic factors determines the severity of asthma and its responsiveness to medications, but the development of the disease is complex (Louis *et al*, 2012; Hopkin, 2020). Due to this complexity, many times, asthma patients are not diagnosed and treated correctly (Bhulani *et al*, 2011). WHO (2002) estimated more than 300 million people are suffering from asthma worldwide, with as many as 250,000 asthma-related deaths each year (Cruz, 2007). The burden of asthma-related deaths is primarily borne by low-income residents of developing nations, including Pakistan (UNICEF, 2013).

Perception about the etiological factors and awareness of asthma symptoms are critical for appropriate treatment and risk factor management of asthma (Boulet *et al*, 1994). A good level of awareness is equally important for every age and gender. Many efforts have been made to develop indexes for assessing the level of asthma awareness, such as studies (Boulet *et al.* (1994; Gabriels *et al.* 2000). There is, however, no known study which can describe the

level of awareness about asthma in Pakistan, the country which is already at very high risk of respiratory diseases, including Covid-19 (0.1 million confirmed Covid-19 cases on 08/06/2020 (COVID, 2020).

Though it is difficult to change the socio-economic conditions of an area due to the long-term requirement of economic growth and social development, awareness can be increased in a comparatively short time for improved public health and reducing the severity of respiratory diseases. Based on this rationale, this paper aims to provide an appraisal of asthma prevalence, existing socio-economic conditions and level of awareness about asthma management in the largest city of Pakistan, i.e. Karachi. Also, it describes the role of asthma awareness as a critical link between asthma prevalence and socio-economic conditions. The study provides evidence for decision-makers to put awareness programs on priority to disseminate health education in the community at every possible level.

Review of Literature

If asthma is not well managed, virus-induced severity is increased (Johnston, 2020). Many studies reported delayed anti-viral immune response in asthmatics (Gavala *et al*., 2013; Uller *et al.*, 2010). In case of viral infection asthma exacerbation severity has also been observed (Contoli *et al.*, 2006. Asthma is therefore, considered as a risk factor for severe impact in Covid-19 due to compromised respiratory system (Johnston, 2020). By considering the asthma as Covid-19 severity factor, in current pandemic situation, centres for disease control and preventions of various countries have released special asthma management guidelines (Pennington, 2020).

Industrial workers in developing countries are at high risk because they are not provided with the standardised preventive working environment (Fairhurst, 2003). As a result, the worldwide prevalence of asthma has doubled in the past 20 years (UNICEF, 2013). Many studies portray the facts and figures about prevalence, frequency, a verity of symptoms, emergency care, quality of life and quality of care concerns (Murphy *et al.*, 2009). To some extent, ethnicity and socio-economic factors have been linked to asthma exacerbation due to exposure to polluted air, smoke and limited access to healthcare facilities (Henschel *et al.*, 2012). An ample number of studies have demonstrated that many asthma patients go undiagnosed, resulting in sub-optimal quality of life (Nolte *et al.*, 2006). Children are at higher risk of misdiagnosis (Sheikh, 2018). Even among adults, asthma may be misidentified as a chronic obstructive pulmonary disease (COPD), emphysema, bronchitis, cystic fibrosis, mesothelioma, smoker's cough, hay fever and other respiratory idiopathic interstitial diseases (Clark *et al.*, 2007). Gaps in proper diagnosis and early treatment of asthma encouraged medical and public health professionals to develop asthma control guidelines, improve quality of health, improve patient awareness and support advocacy around asthma-related public issues, e.g. socio-environmental issues like tobacco smoking, indoor quality of air, out-door pollution (Greene *et al.*, 2013).

In general, perceptions about respiratory diseases and asthma are significantly related to levels of education and susceptibility to these illnesses (Nolte *et al*, 2006). Poor education may lead to misconceptions regarding asthma, such as the belief that it is a contagious disease (Martinez, 2009). Furthermore, uninformed asthma patients may ignore less severe symptoms or either fail to report to their physician or to seek medical help in a timely manner (Yacoub *et al*, 2007). This results in the progression of the disease and leads to the development of severe asthma attacks or complications requiring emergency care (Lundbäck *et al.*, 2001).

The literature is scarce and insufficient regarding asthma and its perception among the population of Karachi. For instance, Asher *et al*. (2006) presented the results of International Study of Asthma and Allergies in Childhood (ISAAC) and analysed that in Karachi, asthma is increasing in children of age 13-14 years from 8.5% (in 1996) to 11.7 (in 2002). Similarly, Shahzad, *et al*. (2006) assessed the prevalence of asthma in tannery workers in Karachi i.e. 10.8% with a higher probability of becoming asthmatics if the workers are aged, illiterate, ever-smoked, Pathan-ethnicity and never used gloves during different tanning tasks. In another study, Khan, *et al*. (2008) presented the assessment of Pakistan Chest Society about asthma patients of Karachi for 2005, which were between 480,000 and 600,000 with 8% prevalence rate in Pakistan. This literature presents an idea of the severity and increasing trends of asthma. Still, it does not establish the history, local environmental etiology and circumstances to address the major causes prevailing in the community.

MATERIALS AND METHODS

Study area

The study area is two towns of Karachi, Landhi and Korangi towns. These two towns reflects many features of typical Karachi, such as industrial areas, commercial markets, planned and unplanned residential localities, climate conditions, physiographic undulations and proximity to the Arabian Sea. Almost 2 million people reside in planned and in slums where population density is high and quality of life is low. The study area is administratively sub-divided into union councils (UCs), (12 in Landhi and 9 in Korangi). These UCs were used as the basic geographical division for conducting the survey and analyzing the data. Figure 1 shows the land use patterns of the study area, where almost 20% area is devoted to industrial land use (Arsalan, 2002; (CDGK, 2007; Qureshi, 2010; Afsar, 2013).

1	Awami Colony	8	Mustafa Taj Colony	15	Khawaja Ajmeer Colony
2	Sharafi Goth	9	Gulzar Colony	16	Daud Chowrangi
3	Burmese Colony	10	Bilal Colony	17	Chakra Goth
4	Sherabad	11	Nasir Colony	18	Muslim Abad
5	Zaman Town	12	100 Quarters	19	Muzzafarabad
6	Korangi	13	Hasrat Mohani Colony	20	Bhutto Nagar
7	Sector 33	14	Landhi	21	Moinabad

Fig. 1. Study Area (1 to 21 are Identifier of Union Councils).

Development and execution of the survey

In this study, a modified version of Global Initiative for Asthma (GINA) questionnaire was used (GINA, 2002). The questionnaire is extended for the assessment of awareness and socio-economic conditions such as education, household income, occupations etc. Awareness questions were rated on a 10-point Likert scale. Common lists of symptoms, medicines, triggers and emergency procedures were provided as options for diagnosis, treatment, prevention and emergency management respectively.

A group of research assistants was trained, and pilot interviews were conducted to pre-test the questionnaire and expected errors. A stratified random sampling method was used with a sample size of 0.1% (n=1388) of total households in the study area. Union councils were used as strata to proportionally distribute the number of the questionnaires. Participants were interviewed directly or indirectly through facilitators or caretakers.

RESULTS

Asthma Prevalence and Socioeconomic Assessment

Asthma prevalence was assessed as a number of identified asthma cases at the time of the survey in comparison to the surveyed population of each union council. Only those people were considered for asthma prevalence assessment who provided the affirmation on the diagnosed by a medical physician as asthmatic. Only vital parameters were included in the study viz. age, gender, income range, occupation, and literacy.

Awareness Assessment

We provided the list of asthma symptoms viz. wheezing, coughing, chest tightness and difficulty in breathing, with two questions – Do you find this symptom in you? In case of Yes, how much do you rate it related to asthma? (Likert scale value 1-10). We repeated the same question structure for all aspects of asthma management.

To estimate the proportion of asthma participants who were being treated for asthma, we determined the utilization of controller medications (e.g., inhaled glucocorticosteroids), reliever medications (e.g., inhaled β2-

agonists), or alternate medications (e.g., Herbal or Homeopathy). Whereas personal emergency management is recorded through nebulization, oxygen therapy, and IM/IV emergency medications.

Prevention was assessed by identifying 40 common asthma indoor and outdoor triggers. For outdoor triggers, proximity was taken as 1 mile (1.6km) from the residence of the respondents. Respondents were given an idea of 1 mile, which they translated according to their understanding about the distances. The list of triggers was compiled from the literature and included the pollution from industrial sources and traffic; occupations and travelling routines; pollens, dust, indoor and outdoor smoke; use of carpets, presence of any unusual odor, change in temperature, severity in weather, domestic pet animals and insects.

The awareness data was categorized based on union councils and then summarized for an individual aspect of asthma management and overall cumulative awareness. Later correlation among cumulative awareness was compared with asthma prevalence and socio-economic conditions in SPSS.

Focus group

In total, 1388 households are surveyed with 71% (987) response rate. Due to lack of consent or incomplete information, 401 (29% of the total) questionnaires were excluded from the study. As a result, 987 survey forms were analyzed in the study. In total 289 subjects were identified who were diagnosed as chronic respiratory patients by health practitioners and were taking medicines for cure and management. Identified respiratory patients were divided into two groups.

i.) Focus group (n=184) - the criterion for this subgroup is:

a. Asthmatics diagnosed by a medical doctor (n=79), OR

b. Self-claimed asthma patients and/or diagnosed by a health practitioner other than a medical doctor (n=37), OR

c. All asthma symptoms (i.e. difficulty in breathing, cough, chest tightness, fast heart rate, wheezing) present in respiratory patients but not diagnosed by any health practitioner (n=68)

ii.) Non-focus group (n=105)–who do not satisfy any of the above, focused-group criteria. In focus group criterion 'a' represents 'asthmatics' which is also used to calculate asthma prevalence, however, criteria 'b' and 'c' define 'suspected asthmatics'.

Table 1. Demographic statistics of respondents.

		Female	Male	Total
A. Focus group	Number	112	72	184
	Percentage	60.9	39.1	100%
Children (< 15 yrs.)	Number	38	18	56
	Percentage	67.9	32.1	30.4% of A
Adults (15 to 60 yrs.)	Number	72	51	123
	Percentage	58.5	41.5	66.8% of A
Elderly (>60 yrs.)	Number	2	3	5
	Percentage	40	60	2.8% of A
B. Asthmatics	Number	44	35	79
	Percentage	55.7	44.3	42.9% of A
Children (< 15 yrs.)	Number	11	10	21
	Percentage	52.4	47.6	26.6% of B
Adults (15 to 60 yrs.)	Number	21	32	53
	Percentage	39.6	60.4	67.0% of B
Elderly (> 60 yrs.)	Number	2	3	5
	Percentage	40	60	6.3% of B
C. Suspected Asthmatics	Number	68	37	105
	Percentage	64.8	35.2	57.1% of A
Children (< 15 yrs.)	Number	27	8	35
	Percentage	77.1	22.9	33.3% of C
Adults (15 to 60 yrs.)	Number	51	19	70
	Percentage	72.9	27.1	66.6% of C
Elderly (> 60 yrs.)	Number	0	0	0
	Percentage	0	0	0

Demographic characteristics

Table 1 shows the demography of respiratory patients of the focus group. In this, adult population is the most affected age group and more weighted towards female (61 % female). However, Children need more attention as a suspected group (33.4%) which is sharing higher values than the verified asthmatics (26.6%). Another peculiar identification is the number of women diagnosed with asthma is less than the number of women reporting consistent symptoms of asthma.

Asthma Prevalence and Socio-economic Characteristics

Figure 2a shows the spatial distribution of asthma prevalence in respondents that varies from 2% to 30% among UCs. The average asthma prevalence for the study area is 8% which is based on declared asthmatics and corresponding to the estimation of Pakistan Chest Society (Khan *et al*, 2008). However, this value may be increased if the suspected asthmatics are also considered. Figure 2b portrays the distribution of literacy rate among the respondents of the focus group. The overall literacy rate of the respondents is alarming, which is almost 45%. The spatial variation of the literacy rate is more affected by the socio-ethical distribution. The lowest literacy rate class in Figure 2b is dominating in the slum areas and varies from 29% to 69% in the study area.

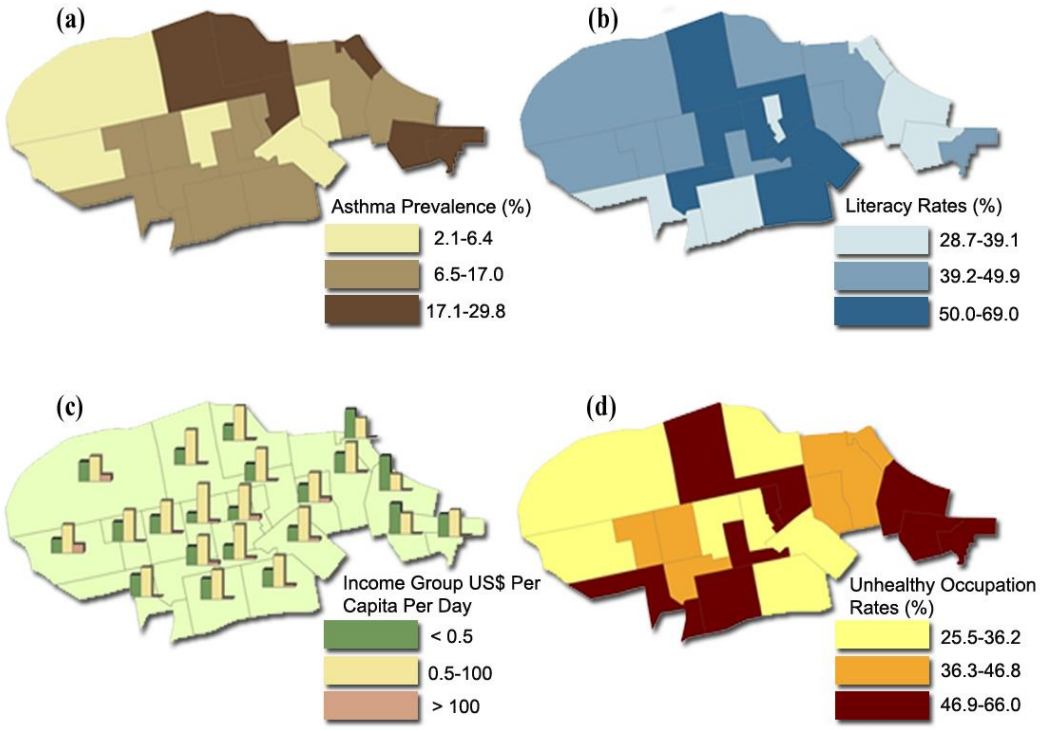


Fig. 2. Comparison of prevalence of asthma in study area and socio-economic indicators: (a) Prevalence of Asthma, (b) Literacy rate, (c) Income groups (d)Unhealthy Occupation

Figure 2c describes the spatial distribution of income groups among respondents. As study area represents economic groups including low income (less than $0.5 per capita per day), middle income (between $0.5 and $100 per capita per day) and higher income (above $100 per capita per day). However, the most representative class of the study area is the middle-income group whereas lower income group is more dominating in the slum areas. More than 45% population IS engaged in occupations susceptible to asthma. Figure 2d is an indicator of occupational hazards including asthma. Most of the unhealthy occupations are associated with industrial works and manufacturing. In case of respiratory diseases; wood working, cotton ginning, leather processing, ceramics development, power battery manufacturing, paints and chemical processing are the main unhealthy occupations in the study area. Most of the workers at risk reside in the neighborhood of the industrial units and slum areas.

Socio-economic status plays a pivotal role in determining health status (Levesque *et al*, 2013). Specifically, many researchers have shown strong associations of respiratory diseases with education, and living conditions which may also be responsible for asthma prevalence (Yacoub *et al*, 2007). Table 2 shows correlation between asthma prevalence and socioeconomic indicators is between 0.36, $p<0.05$ (with literacy) and 0.43, $p<0.02$ (with Low-income group).It strengthens the idea of the inverse relationship between asthma and the level of education ($r=-0.36$, $p<0.05$) as described by Radic, *et al*. (2014). According to Blanc, *et al*. (2006) low-income earners in the slum areas are more prone to asthma due to the deprivation of good quality of life and struggle to access the basic necessities of their lives.

Asthma awareness

Figure 3a summarizes asthma awareness in form of box-whisker plot of asthma management aspects and cumulative level. In 184 respondents, the understanding of asthma treatment is comparatively higher than all other aspects with the median value at 5. Contrary to this, understanding of asthma prevention is at the lowest level where the upper limit of Q3 (75% of data) is no more than 5. The diagnosis has some major issues in the study area as suspected asthmatics having all asthma symptoms but not diagnosed by any medical doctor or there are some self-claim asthmatics as well. However, understanding of asthma symptoms is not as good as of treatment method or emergency management. The last box in Figure 3a shows the cumulative awareness as a generalized measure for the study area. The central value of cumulative awareness is 4.5 that shows below average on the 10-point Likert scale.

Figure 3b further analyses the data at union council level with asthma management aspects split and cumulative awareness. It provides the comprehensive understanding of geographical distribution. Out of 21, seven union councils have more than 4.5 (cumulative awareness of the study area) but only two of them have value above average i.e. 6. Four union councils have value 5, two have 4.5, ten have 4 and the lowest cumulative value is 2.5. It is evident that level of awareness is comparatively low in the peripheral slum areas. Afsar, *et al*. (2013) described these areas attributed to unhygienic, scarce public amenities and neighborhood of poor working class. In these areas, ambient environment is highly polluted.

Colón-Ramos, *et al*. attempted to understand the relationship between the socio-economic status and health awareness and significantly correlated different health concerns (Colón-Ramos *et al.*, 2007). In our study, literacy stood out at the top having a considerably high relationship ($r=0.77$, $p < 0.001$) (Table 2). Secondly, an association of asthmatics with unhealthy occupation is also among the major reasons of asthma exacerbation. The relationship of awareness with unhealthy occupation ($r = -0.41$, $p < 0.02$) justifies that relationship. It shows that low level of literacy provokes the more involvement in unhealthy occupation ($r = -0.38$, $p < 0.04$) without taking care of health or understanding of long-term health impacts. As a result, asthma prevalence is higher in people associated with unhealthy occupation ($r = 0.38$, $p < 0.04$) and have a low level of awareness ($r = -0.39$, $p < 0.04$).

Table 2. Relationship of Asthma Prevalence and Cumulative Awareness with Socio-economic Indicators.

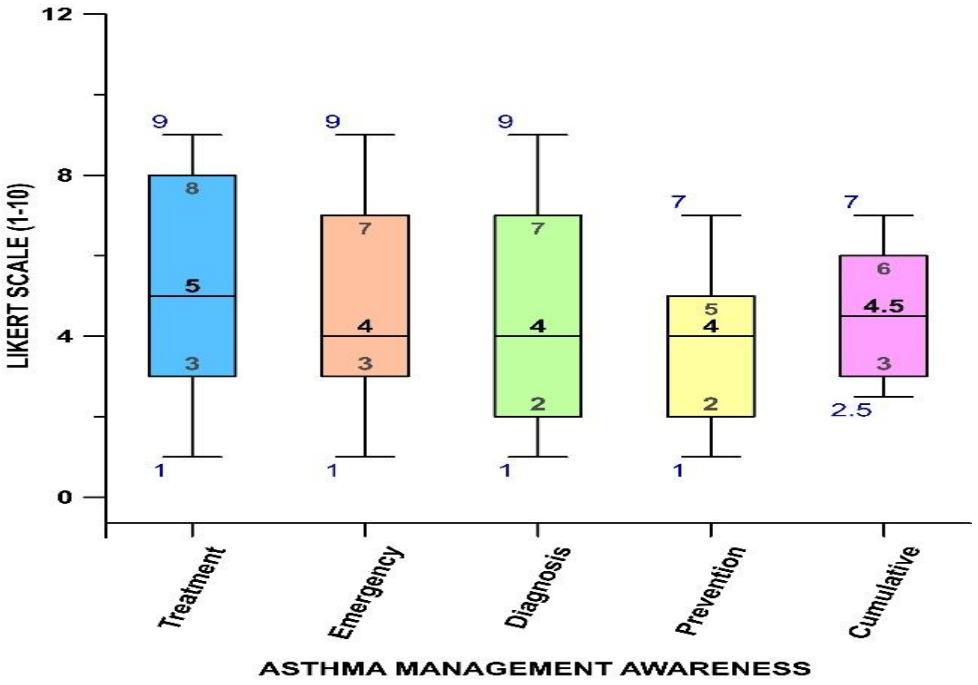
Correlation with Asthma Prevalence			
	r	P	Covariance
Cumulative Awareness (Likert 1-10)	-0.39*	0.04	-2.45
Literacy (%)	-0.36	0.05	-33.40
Unhealthy Occupations (%)	0.38*	0.04	32.43
Low Income Group (% share)	0.43*	0.02	38.99
Middle Income Group (% share)	-0.25	0.13	-20.43
High Income Group (% share)	-0.56**	0.00	-18.56
Correlation with Asthma Cumulative Awareness			
	r	P	Covariance
Asthma Prevalence (%)	-0.39*	0.04	-2.45
Literacy (%)	0.77**	0.00	8.04
Unhealthy Occupations (%)	-0.42*	0.03	-4.02
Low Income Group (% share)	-0.03	0.45	-0.30
Middle Income Group (% share)	-0.04	0.44	-0.34
High Income Group (% share)	0.17	0.23	0.64

*. Correlation is significant at the 0.05 level (N = 21)

**. Correlation is significant at the 0.01 level

Table 2 also shows the relationship of level of awareness with household income. Many authors have proven as a potentially important indicator of health status or more important than education and health (Duncan *et al.*, 2002). We observed a similar trend in form of asthma prevalence and low-income group ($r = 0.43$, $p < 0.02$). However, the result shows total randomness on scatter plots without any relationship between cumulative awareness and income classes.

(a)



(b)

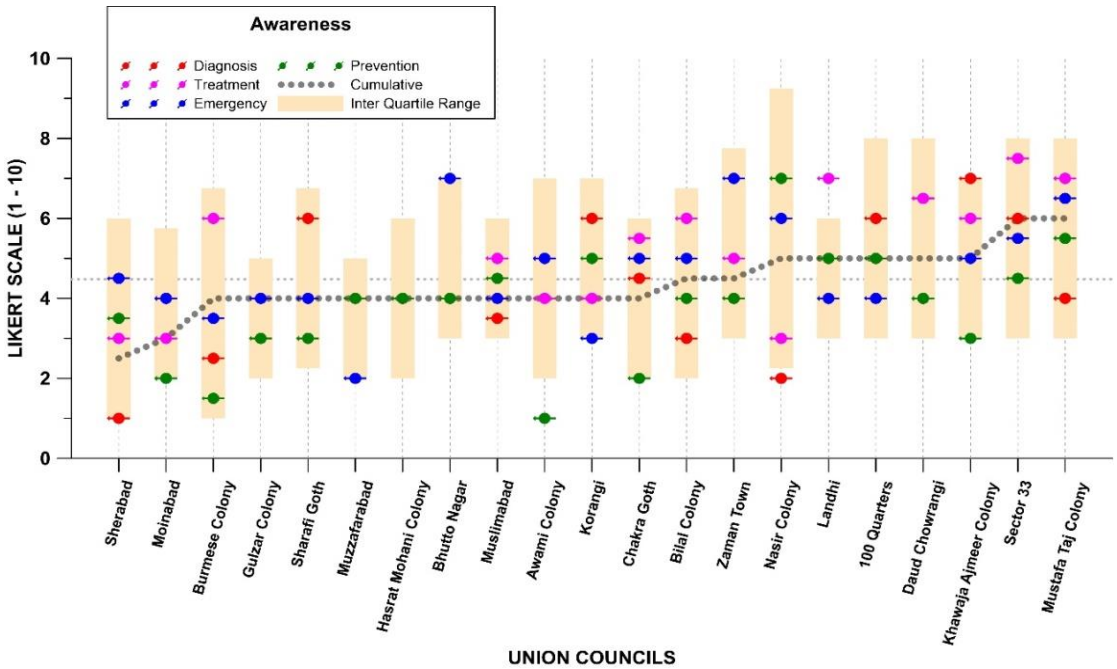


Fig. 3. Summary of Asthma Awareness.

(a) Box represents the first quartile (Q1, 25%) at the bottom and third quartile (Q3, 75%) at the top. The center shows the median value, whereas whiskers are at 10% and 90% of data

(b) Geographical distribution of asthma awareness among Union Councils

DISCUSSION

In this study results suggest that the level of awareness about asthma symptoms, regular and emergency management and knowing asthma triggers is very low in the study area. The main cause of this awareness is a low level of literacy, which is also an outstanding cause of asthma prevalence. The spreading of information regarding disease by healthcare institutions, clinics, governmental and non-governmental officials and policymakers can be very helpful for better understanding of asthma and its management in the community as many of them are suggested by Bodenheimer *et al.* (2002).

The study shows that study area dwellers mainly concerned with the living, but they do not care about the prevailing issues in their surroundings. Thus, they do not realize the impacts of their living and working environment on their health. Many researchers explain the poor level of awareness with the vital indicators of society (Kaptein *et al.*, 2010). For example, illiteracy keeps the people disinterested about unhygienic living environments, and they do not know about the harmful effects of the hazardous pollutants in their environment (Fishwick *et al.*, 2007).

In Pakistan, less than 1% of GDP expenditure on healthcare, around 61% rural population (WorldBank, 2020), high level of poverty with illiteracy, the deprived status of women and poor municipal services delivery are the main factors of poor health indicators (Shaikh and Hatcher, 2005). Due to the poor economic, social and environmental performance, Pakistan is considered at very high level of infectious disease risk. Pakistan stands at rank 32 out of 195 assessed countries in global infectious disease vulnerability index (Moore *et al.*, 2017) and at rank 29 out of 190 assessed countries in inform global risk index (GBD 2015; GRI and GRI , 2018,). In the limited healthcare capacity with already constrained financial resources, socio-economic development is far away but awareness can be improved with less effort and in short period of time. But this could only be achieved when all stakeholders and potential partners are fully committed, involved and empowered to take charge of addressing this burden collectively as suggested by studies (Moore, 2010; Licari *et al.*, 2020).

Conclusions

We explored the level of awareness about asthma in Pakistan and its association with socio-economic conditions. We conducted a questionnaire survey with 0.1% sample of households (n=1388) in Landhi and Korangi towns of Karachi. We used 10-point Likert Scale to develop an awareness index based on asthma diagnosis, treatment, emergency management and prevention. We found very low (4.5 out of 10) cumulative asthma awareness with 8% prevalence. Literacy stood out at the top having a strong relationship with cumulative asthma awareness. We found that a low level of literacy provokes more involvement in unhealthy occupation and careless behavior about asthma triggers. As a result, asthma prevalence is higher in people associated with unhealthy occupation and have a low level of awareness without proper health and safety measures. Though socioeconomic development of an area is a long journey, especially in developing countries, awareness programs can make better public health in a short time especially. This strategy will also reduce the level of Covid-19 severity as asthma is considered one of the risk factors.

Supplementary Materials: Material/data could provide on request.

Author Contributions:

MHA (Mudassar Hassan Arsalan) and IAK (Imran Ahmed Khan) designed and supervised the study. MRM (Mohammed Raza Mehdi), SQ (Salman Qureshi), SJHK (Syed Jamil Hasan Kazmi) and MQ (Maria Qadri) analyzed the results and contribute in this manuscript. All authors drafted and revised the paper. All authors have read and agreed to the published version of the manuscript.

Funding: "This research received no external funding".

Conflicts of Interest: "The authors declare no conflict of interest."

Acknowledgements

Authors are grateful to all anonymous participants who collaborated during this study. Authors thank the Department of Geography, University of Karachi, and the research assistants for the support to conduct questionnaire survey.

REFERENCES

Afsar, S., S.S. Ali and S. J. H. Kazmi (2013). Assessment the quality of life in Karachi city through the integration of space and spatial technologies. *Journal of Basic and Applied Sciences*, 9: 373-388.

Arsalan, M. H. (2002). Monitoring spatial'p atterns of air pollution in Karachi• metropolis: A GIS and remote sensing perspective. Doctoral dissertation, University of Karachi, Karachi-Pakistan.

Asher, M. I., S. Montefort, B. Björkstén, C.K. Lai, D. P. Strachan, S. K. Weiland and ISAAC Phase Three Study Group. (2006). Worldwide time trends in the prevalence of symptoms of asthma, allergic rhinoconjunctivitis, and eczema in childhood: ISAAC Phases One and Three repeat multicountry cross-sectional surveys. *The Lancet*, 368(9537): 733-743.

Bhulani, N., S. Lalani, A. Ahmed, Y. Jan, U. Faheem, A. Khan, Z. Samani, W. Aman, F. Bhatti, O. Hayat and S. Saleem (2011). Knowledge of asthma management by general practitioners in Karachi, Pakistan: comparison with international guidelines. *Primary Care Respiratory Journal*, 20(4): 448-451.

Blanc, P.D., I.H. Yen, H. Chen, P.P. Katz, G. Earnest, J.R. Balmes, L. Trupin, N. Friedling, E.H. Yelin and M.D. Eisner (2006). Area-level socio-economic status and health status among adults with asthma and rhinitis. *European Respiratory Journal*, 27(1): 85-94.

Bodenheimer, T., E.H. Wagner and K. Grumbach (2002). Improving primary care for patients with chronic illness. *Jama*, 288(14): 1775-1779.

Boulet, L. P., P. Leblanc and H. Turcotte (1994). Perception scoring of induced bronchoconstriction as an index of awareness of asthma symptoms. *Chest*, 105(5): 1430-1433.

CDGK (2007). Karachi strategic development plan- 2020. City District Government Karachi, Karachi, 2007.

Clark, N. M., Z.M. Gong, S. J. Wang, X. Lin, W.F. Bria and T. R. Johnson (2007). A randomized trial of a self-regulation intervention for women with asthma. *Chest*, 132(1): 88-97.

Colón-Ramos, U., E.K. Kabagambe, A. Baylin, A. Ascherio, H. Campos and K. E. Peterson (2007). Socio-economic status and health awareness are associated with choice of cooking oil in Costa Rica. *Public health nutrition*, 10(11): 1214-1222.

Contoli, M.,S.D. Message, V. Laza-Stanca, M.R. Edwards, P. A. Wark, N. W. Bartlett, ... and L. Slater (2006). Role of deficient type III interferon-λ production in asthma exacerbations. *Nature medicine*, 12(9): 1023-1026.

Corne, J. M., C. Marshall, S. Smith, J. Schreiber, G. Sanderson, S.T. Holgate and S.L. Johnston (2002). Frequency, severity, and duration of rhinovirus infections in asthmatic and non-asthmatic individuals: a longitudinal cohort study. *The Lancet*, 359(9309): 831-834.

Cruz, A. A. (2007). *Global surveillance, prevention and control of chronic respiratory diseases: a comprehensive approach*. World Health Organization.

Duncan, G. J., M.C. Daly, P. McDonogh and D.R. Williams (2002). Erratum: Optimal indicators of socioeconomic status for health research. *American Journal of Public Health*, 92(8): 1212-1212.

Fairhurst, S. (2003). Hazard and risk assessment of industrial chemicals in the occupational context in Europe: some current issues. *Food and chemical toxicology*, 41(11): 1453-1462.

Fishwick, D., Bradshaw, L., Davies, J., Henson, M., Stenton, C., Burge, S., Niven, R., Warburton, C.J., Hendrick, D., Rogers, T. and Rawbone, R., (2007). Are we failing workers with symptoms suggestive of occupational asthma?. Primary Care Respiratory Journal, 16(5), 304-310.

Gabriels, R. L., M.Z. Wamboldt, D. R. McCormick, T. L. Adams and S.R. McTaggart (2000). Children's illness drawings and asthma symptom awareness. *Journal of Asthma*, 37(7): 565-574.

Gavala, M. L., H. Bashir and J. E. Gern (2013). Virus/allergen interactions in asthma. *Current allergy and asthma reports*, 13(3): 298-307.

GBD (2015). Eastern Mediterranean Region Adolescent Health Collaborators, 2018. Adolescent health in the Eastern Mediterranean Region: findings from the global burden of disease 2015 study. *International journal of public health*, 63(1): 79-96.

GINA, (2002). Global Strategy for Asthma Management and Prevention. Global Initiative for Asthma, 2002. [Online]. Available: www.ginasthma.org

Greene, T., M. Amour, A. Koyfman and M. Foran (2013). Asthma essentials: Les points essentiels de l'asthme. *African Journal of Emergency Medicine*, 3(4): 182-188.

GRI, I. E., and E.I. GRI (2018). Incorporating epidemics risk in the INFORM Global Risk Index.

Henschel, S., R. Atkinson, A. Zeka, A. Le Tertre, A. Analitis, K. Katsouyanni, O. Chanel, M. Pascal, B. Forsberg, S. Medina and P.G. Goodman (2012). Air pollution interventions and their impact on public health. *International journal of public health*, 57(5): 757-768. Incomplete

Hopkin, J. (2020). *COVID, Coronavirus. "Global cases by Johns Hopkins CSSE. 2020*." Avialable online at: https://coronavirus. jhu. edu/map. html (accessed May 16, 2020) (19).

Johnston, S. L. (2020). Asthma and COVID-19: Is asthma a risk factor for severe outcomes?. *Allergy*, 75(7):1543-1545.

Kaptein, A. A., Klok, T., Moss-Morris, R., and Brand, P. L. (2010). Illness perceptions: impact on self-management and control in asthma. Current opinion in allergy and clinical immunology, 10(3), 194-199.

Khan I. A., M.H. Arsalan and S. Afsar (2008). Analysis of Asthma Risk Zones in Selected Areas of Karachi: A Perspective from Landhi and Korangi Towns. In: *13th National All Pakistan Geographical Conference on Geography and Human Development.* Department of Geography, University of Karachi.

Levesque, J. F., S. Mukherjee, D. Grimard, A. Boivin and S. Mishra (2013). Measuring the prevalence of chronic diseases using population surveys by pooling self-reported symptoms, diagnosis and treatments: results from the World Health Survey of 2003 for South Asia. *International Journal of Public Health*, 58(3):L 435-447.

Licari, A., G. L. Marseglia and G. Ciprandi (2020). The relevance of symptom perception in the management of severe asthma in adolescents. *Allergologia et Immunopathologia*. 48(6):810-813.

Louis, R., F. Schleich, J.L. Corhay and E. Louis (2012). Asthma: a complex disease determined by genetic and environmental factors. *Revue medicale de Liege*, 67(5-6): 286-291.

Lundbäck, B., E. Rönmark, E. Jönsson, K. Larsson and T. Sandström (2001). Incidence of physician-diagnosed asthma in adults—a real incidence or a result of increased awareness? Report from the Obstructive Lung Disease in Northern Sweden Studies. *Respiratory medicine*, 95(8): 685-692.

Martinez, F. D. (2009). Managing childhood asthma: challenge of preventing exacerbations. *Pediatrics*, 123(Supplement 3): S146-S150.

Moore, M., B. Gelfeld and C. P. Adeyemi Okunogbe (2017). Identifying future disease hot spots: infectious disease vulnerability index. *Rand health quarterly*, 6(3).

Moore, S. (2010). From awareness to action on the social determinants of health.

Murphy, D. M., and P.M. O'Byrne (2010). Recent advances in the pathophysiology of asthma. *Chest*, 137(6): 1417-1426.

Murphy, K. R., R.S. Zeiger, M. Kosinski, B. Chipps, M. Mellon, M. Schatz, and S. Ramachandran (2009). Test for respiratory and asthma control in kids (TRACK): a caregiver-completed questionnaire for preschool-aged children. *Journal of Allergy and Clinical Immunology*, 123(4): 833-839.

Nolte, H., Nepper-Christensen, S. and V. Backer (2006). Unawareness and undertreatment of asthma and allergic rhinitis in a general population. *Respiratory medicine*, 100(2): 354-362.

Pennington, E. (2020). Asthma increases risk of severity of COVID-19. *Clevel. Clin. J. Med.,* doi: 10.3949/ccjm.87a.ccc002.

Qureshi, S. (2010). The fast growing megacity Karachi as a frontier of environmental challenges: Urbanization and contemporary urbanism issues. *Journal of Geography and Regional Planning*, 3(11): 306-321.

Radic, S. D., B.A. Milenkovic, B. S. Gvozdenovic, Z. M. Zivkovic, I. M. Pesic and D. D. Babic (2014). The correlation between parental education and their knowledge of asthma. *Allergologia et Immunopathologia*, 42(6): 518-526.

Shahzad, K., S. Akhtar and S. Mahmud (2006). Prevalence and determinants of asthma in adult male leather tannery workers in Karachi, Pakistan: a cross sectional study. *BMC public health*, 6(1): 292.

Shaikh, B. T. and J. Hatcher (2005). Health seeking behaviour and health service utilization in Pakistan: challenging the policy makers. *Journal of public health*, 27(1): 49-54.

Sheikh, M. A. (2018). Childhood adversities and chronic conditions: examination of mediators, recall bias and age at diagnosis. *International Journal of Public Health*, 63(2): 181-192.

Uller, L., M. Leino, N. Bedke, D. Sammut, B. Green, L. Lau, P.H. Howarth, S.T. Holgate and D.E. Davies (2010). Double-stranded RNA induces disproportionate expression of thymic stromal lymphopoietin versus interferon-β in bronchial epithelial cells from donors with asthma. *Thorax*, 65(7): 626-632.

Unicef. (2013). *State of the World's Children 2015*. Country Statistics.

WB. (World Bank) Rural population (% of total population). [Online]. Available: https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS

WHO (World Health Organisation). (2002). *The world health report 2002: reducing risks, promoting healthy life*. World Health Organization.

Yacoub, M.R., K. Lavoie, G. Lacoste, S. Daigle, J. L'archevêque, H. Ghezzo, C. Lemière and J.L. Malo (2007). Assessment of impairment/disability due to occupational asthma through a multidimensional approach. *European Respiratory Journal*, 29(5): 889-896.

(*Accepted for publication July 2021*)