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Original Research Article

Bio-social correlates of indoor air pollution among women residing in rural areas of Mysuru

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ABSTRACT

Background: Indoor air pollution (IAP) remains a major global public health hazard more so in developing countries where the use of biomass fuels is still very common. Since women tend to be in charge of cooking and young children commonly spend time with their mothers while they are cooking, women and young children are disproportionately affected. In this background, the present study was proposed to assess the bio-social correlates of IAP among women residing in rural areas.
Methods: A cross-sectional study was conducted in rural field practice areas of JSS Medical College, Mysuru for six months. Totally 210 households were included by probability proportionate to the size sampling technique. Data was collected by structured questionnaire with details on socio-demographic characteristics, house and fuel characteristics and indoor air pollution meter values of particulate matter (PM) 1, 2.5, 10 respectively.
Results: Among 210 study participants, 28 (13%) had indoor air pollution in their houses. 99% of the households were using LPG. The mean concentrations of pollutants like PM10, PM2.5 and PM1.0 were higher among the houses with indoor air pollution compared to their counterparts ($p<0.001$). A statistically significant association was found between age, socioeconomic status, and poverty line and the presence of indoor air pollution.
Conclusions: The present study showed that IAP had a strong relation to socio-cultural factors such as age, poverty and economic level. As women are involved in cooking in the majority of Indian households, they are more prone to be affected by the negative effects of solid fuel usage.

Keywords: Indoor air and health, Indoor air pollution, Indoor air quality, Particulate matter

INTRODUCTION

According to the World Health Organization (WHO), “air pollution is contamination of the indoor or outdoor environment by any chemical, physical or biological agent that alters the natural characteristics of the atmosphere”. Common sources of air pollution include household combustion devices, motor vehicles, industrial facilities, and forest fires. Particulate matter, carbon monoxide, ozone, nitrogen dioxide, and sulphur dioxide are all major public health concerns.[1]

In 2019, air pollution accounted for 6.67 million deaths globally and 3.6% of the risk factors for indoor air pollution (IAP), also known as home pollution, which causes disability-adjusted life years (DALYs).[2] Indoor environment conditions have a significant impact on human well-being, as most people spend around 90% of their time indoors, mainly at home or at the workplace. Its possible to find dangerous pollutants including carbon monoxide (CO), volatile organic compounds (VOCs), par ticulate matter (PM), aerosol, and biological contaminants inside buildings. As a result, research on air quality control has begun to shift from outdoor to indoor environments over the last decade, reflecting lifestyle changes associated with increased levels of urbanisation.[3]

Indoor air pollution (IAP) continues to pose a serious global health threat. Solid fuels, including biomass fuels (wood, dung, agricultural residues) and coal, continue to meet the energy needs of one-half of the world's population, and up to 95% in poor countries.[4] In contrast, most urban households use liquefied petroleum gas (LPG) as their primary cooking fuel; however, approximately 19% of urban households use biomass fuel for cooking. Poverty, a lack of access to improved cooking fuel, and a lack of awareness about the dangers of biomass emissions are all major factors driving their widespread use. The use of biomass fuel has negative health consequences because it emits a large number of air pollutants such as carbon monoxide (CO), sulphur dioxide (SO_2), respirable particulate matter (PM2.5 and PM10), polycyclic aromatic hydrocarbon (PAH), benzene, and metals such as lead and copper during incomplete combustion.[5]

An average Indian woman is obliged to do domestic cooking. On average, an Indian woman spends about four to six hours per day cooking.[6] Women and young children are disproportionately affected because women are primarily responsible for cooking, and children frequently spend time with their mothers while they are engaged in cooking activities.[4] Young children living in households exposed to biomass fuel have a two to three times greater risk of developing acute lower respiratory tract infection (ALRI) compared with those living in households using cleaner fuels or suffering less exposure to smoke.[7]

Chronic indoor exposure to biomass smoke can result in a variety of health problems, including chronic obstructive pulmonary disease (COPD), tuberculosis (TB), cataracts, and adverse pregnancy outcomes such as stillbirths, low birth weight, intrauterine growth retardation, and infant mortality.[5]

Although a few Indian studies have found a link between indoor air pollution caused by biomass fuel and specific disease conditions, few have considered attributable fractions, which are a more policy-oriented way of expressing the burden. Also, there is a lack of studies which provide comprehensive estimates for a range of conditions caused by biomass-associated indoor air pollution. In this background, the present study was undertaken to assess the bio-social correlates of indoor air pollution among women residing in rural areas.

METHODS

Study design and setting

This cross-sectional study was conducted among 210 women in the age group 18 years and above who are permanently residing in the rural field practice areas (residing in the same village since the last year according to the definition in the census 2011) of the department of community medicine, JSS Medical College, Mysuru, over a period of six months (January to June 2021). The study protocol was approved by the institutional ethical committee and consent was obtained from the participants after explaining the purpose and procedure of the study.

Inclusion criteria

Women in the age group 18 years and above who are permanently residing in the rural areas (residing in the same village since last one year according to definition in census 2011).

Exclusion criteria

Women who are not consenting to participate in the study.

Sample size and sampling technique

Based on the reported concentration average 24-hour exposure rates to particulate matters leading to indoor air pollution to be 231±109 mg/m^3 among the households using biomass fuel with 15% relative allowable error, alfa level of 5%, the sample size was calculated to be 206 which was be rounded off to 210.[20]

Stage 1: multistage sampling was used to select the villages from 3 rural fields: Hadinaru, Suttur and Kadakola. Stage 2: the probability proportionate to size technique was used to find out the number of houses to be included in each village. Stage 3: simple random sampling was used for the selection of houses from the villages after collecting the list of houses from the local panchayath/Anganwadi centre.

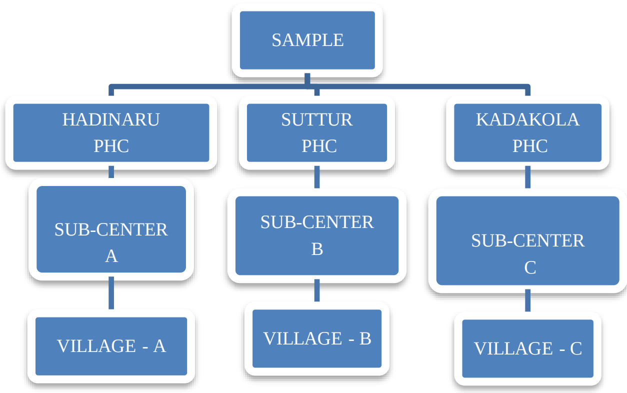

Figure 1: sampling technique.

Data collection

Data was collected by face-to-face interviews using a semi-structured questionnaire to obtain the following details. Socio-demographic characteristics like age, gender, education, occupation, income, marital status, socioeconomic status, reason for not using LPG, cultural practices associated with cooking procedures etc. Information on kitchen type (separate/non-separate, with/without platform) and, type of fuel used for cooking, permanent ventilation in the kitchen, presence of exhaust, history of tobacco smoking and indoor pollution level. The indoor particulate matter (PM10, PM2.5 and PM1) and volatile organic compounds (VOCs) was measured in each home using the portable air quality pollution meter detector. Prana air CAIR + air quality monitor measuring AQI, PM2.5, PM10, temperature, humidity which helps to detects levels of PM1, PM2.5, PM10 HCHO and TVOC in the air around us through laser scattering detection was used.

Data analysis

The data collected was entered in a Microsoft Excel 2019 spreadsheet followed by analysis using SPSS version 26 (Statistical package for the social science, Licensed to JSSAHER) Windows, version 26.0. (IBM Corp. Released 2019. IBM SPSS Statistics for Armonk, NY, USA). Descriptive statistics involving demographic characteristics were represented using variables as mean±standard deviation (SD), while categorical variables were reported in terms of frequency (n) and percentage (%). Inferential statistical tests like Chi-square tests/Fisher exact test were used to find the association between sociocultural factors influencing indoor air pollution. The data distribution was represented using appropriate tables. A p value of less than 0.05 was considered statistically significant.

RESULTS

The majority of the women in the study, 105 (50%), were between the age of 41 and 60 years, followed by 32% (67) who were between the age group of 21 and 40 years. 149 (71%) were unmarried, and 188 (90%) were from nuclear families. It can be seen that among (n=210) study subjects, 89 (42%) were illiterate, 20 (9.5%) are intermediate or diploma holders, and 20 (9.5%) were graduates. 113 (53.8%) of the study participants were unemployed, and 116 (55%) earned between Rs 11,000 and 20,000 per month. 117 (84%) of the study participants lived in semi-pucca houses, while 33 (16%) lived in pucca houses.139 people (66%) were from the lower middle socioeconomic class, and 204 people (97%) had BPL card (Table 1).

Table 1: Socio-demographic characteristics of study participants.

Variables	Category	Frequency	Percentage
Age (in years)	<20	9	4
	21-40	67	32
	41-60	105	50
	61-80	27	13
	>80	2	1
Marital status	Married	24	11
	Unmarried	149	71
	Widow	37	18
Type of family	Nuclear	188	90
	Joint	22	10
Education	Illiterate	89	42
	Primary school	6	3
	Middle school	14	7
	High school	61	29
	Intermediate/diploma	20	9.5
	Graduate	20	9.5
Occupation	Unemployed	113	53.8
	Elementary occupation	31	14.8
	Plant and machine operations	21	10
	Crafts and related trade worker	11	5
	Skilled agriculture and fishery worker	14	6.7
	Skilled workers, shop and market sales worker	14	6.7
	Clerks	2	1
	Technicians and associate professionals	4	2
Monthly income	1000 to10000	36	17
	11000 to 20000	116	55
	21000 to 30000	50	24
	31000 to 40000	8	4
Type of house	Semi pucca	177	84

Continued.

Variables	Category	Frequency	Percentage
	Pucca	33	16
Socio-economic status (BG Prasad classification)	Upper lower	10	5
	Lower middle	139	66
	Upper middle	57	27
	Upper class	4	2
Poverty line	BPL	206	98
	APL	4	2

Table 2: House and fuel characteristics.

Variables	Category	Frequency	Percentage
Ventilation inside the house	Adequate	196	93
	Inadequate	14	7
Cross ventilation	Present	181	86
	Absent	29	14
LPG connection	Yes	208	99
	No	02	1
Prefer wood during festivals	Yes	10	5
	No	200	95
Prefer wood during social gatherings	Yes	05	2
	No	205	98

According to Table 2, it was observed that among the study participants, the majority of study subjects had adequate ventilation inside their house i.e., 196 (93%) and 86% had cross ventilation. 208 (99%) of the population had an LPG connection. During festivals and social gatherings, only 5% and 2% preferred wood, respectively.

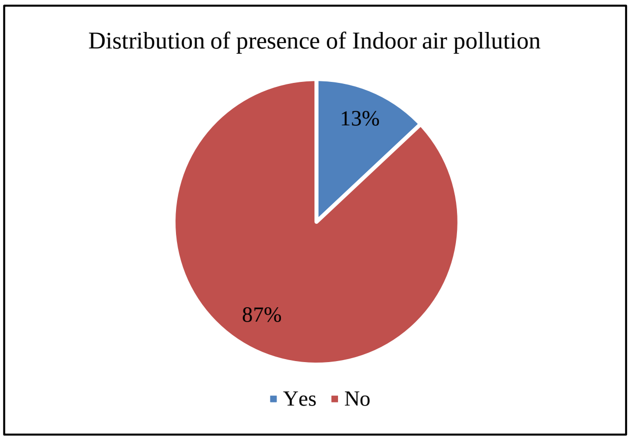

Figure 2: Distribution according to the presence of indoor air pollution.

According to Figure 2, only 28 people (13.3%) had indoor air pollution in their houses, while 182 people (86.7%) did not.

The mean value of different pollutants, namely PM10 (µg/m^3), PM2.5 (µg/m^3), PM1.0 (µg/m^3), and TVOC (µg/m^3), was 61.90±41.2084, 46.976±23.5684, 31.524±38.1558, and 0.1633±1.54679, respectively. (Table 3).

Table 3: Pollutants of indoor air pollution.

Pollutants (µg/m^3)	Mean	Std. deviation
PM10	61.190	41.2084
PM2.5	46.976	23.5684
PM1.0	31.524	38.1558
TVOC	0.1633	1.54679

Table 4: Comparison of pollutants among houses with and without indoor air pollution.

Pollutants (µg/m3)	Indoor air pollution		P value
	Present (n=28)	Absent (n=182)	
PM 10	69.50 (40.5-81.5)	56.0 (41.5-78.0)	0.0025
PM 2.5	57.0 (36.0-68.5)	44.0 (32.0-54.2)	0.001
PM 1.0	37.5 (24.5-41.5)	28.0 (21.0-34.0)	0.001
TVOC	0.07 (0.06-0.08)	0.00 (0.00-0.00)	0.824

From the Table 4 we can observe that, the mean PM10, PM2.5 and PM1.0 concentrations was higher among the houses with indoor air pollution compared to their counterparts and it was found to be statistically significant.

A statistically significant relationship was found between age (p=0.02) socioeconomic status (p=0.004), and poverty line (p=0.039) and the presence of indoor air pollution.

Table 5: Socio-cultural factors associated with indoor air pollution.

Variables	Category	Indoor air pollution			Chi-square	P value
		Present	Absent	Total		
Age (in years)	<20	3 (10.7)	6 (3.2)	9 (4.2)	9.72	0.02*
	21-40	12 (42.8)	55 (30.2)	67 (32)		
	41-60	7 (25)	98 (53.4)	105 (50)		
	>61	6 (21.4)	23 (12.6)	29 (13.8)		
Type of family	Nuclear	25 (92.5)	163 (89.5)	188 (89)	0.001	0.96
	Joint	3 (11.1)	19 (10.4)	22 (10.4)		
Socioeconomic status	Upper lower	2 (6.6)	8 (4.4)	10 (4.7)	13.28	0.004*
	Lower middle	16 (53.4)	123 (68.3)	139 (66.1)		
	Upper middle	8 (30)	49 (26.8)	57 (27.1)		
	Upper	2 (10)	2 (0.5)	4 (2)		
Poverty line	BPL	26 (93.4)	180 (98.8)	206 (98.1)	4.24	0.039*
	APL	2 (6.6)	2 (1.2)	4 (1.9)		
Type of house	Pucca	5 (17.8)	28 (15.3)	33 (15.7)	0.112	0.73
	Semi pucca	23 (82.1)	154 (84.6)	177 (84.2)		
Ventilation	Adequate	26 (92.8)	170 (93.4)	196 (93.3)	0.01	0.91
	Inadequate	2 (7.1)	12 (6.6)	14 (6.6)		
Cross ventilation	Present	25 (89.2)	156 (85.7)	181 (86.1)	0.26	0.61
	Absent	3 (10.7)	26 (14.2)	29 (13.8)		
LPG connection	Present	27 (96.5)	181 (99.4)	208 (99)	2.22	0.13
	Absent	1 (3.44)	1 (0.6)	2 (9.5)		
Preference of wood during festivals	Yes	2 (7.1)	8 (4.3)	10 (4.7)	0.40	0.52
	No	26 (92.8)	174 (95.6)	200 (95.2)		
Preference of wood during social gathering	Yes	2 (7.4)	3 (1.6)	5 (2.3)	3.15	0.07
	No	26 (92.8)	179 (98.3)	205 (97.6)		

P value <0.05- statistically significant.

DISCUSSION

The interior environment is contaminated by various gases and particles produced during burning. The current study discovered that indoor air pollution has a strong link to sociocultural factors. The use of firewood, cow dung, and other biomass as primary sources of energy for cooking was linked to the economic position, poverty level, and a preference for utilizing wood during social events. Pollutants such as carbon monoxide, carbon dioxide, Sulphur dioxide, nitrogen dioxide, volatile organic compounds, and/or hydrocarbons are released when firewood and cow dung are used as fuels.[8]

Households using clean fuel for cooking in rural areas were around 69.3% in Karnataka as per the National Family Health Survey (NFHS)-5 (2019-2021). The present study found that about 99% of the households were using LPG. Only 1% were using unclean fuel and solid fuel for cooking. In contrast to this, a study conducted by Ellegard et al found that 35% of the respondents cook their food either on wood, coal, sawdust, or kerosene oil.[9] It has become all the time more apparent that IAP is often the source of more personal exposure than outdoor air pollution, particularly but not entirely in homes where biofuels are used.

In our study, the mean indoor PM 10 concentration and standard deviation were 61.190+41.21, the PM2.5 concentration was 46.98±23.57, and the PM1 concentration was 31.52±38.16. According to the study conducted by Nadali et al Hourly average concentration and standard deviation (SD) of PM10 in indoor and outdoor at residential buildings were 63.5±27.4 and 90.1±33.5 µg/m^3, respectively. Indoor and outdoor concentrations of PM2.5 in residential buildings were 39.4±18.1 and 49.5±18.2 µg/m^3 and for PM1 the concentrations were 4.3±7.7 and 6.5±10.1 µg/m^3, respectively. They estimated that negative air ions can remove nearly 71.47% of PM10, 79.86% of PM2.5, and 61.25% of PM1 in indoor residential buildings.[10]

The measured concentration of PM2.5 for rural households is higher than the 24-hour standard average of 35 µg/m^3 according to the National Ambient Air Quality Standards (NAAQS) 2020. In the same group of houses the measured concentration of PM10 is less than 150 µg/m^3 (according to NAAQS-2020) which says that there is no presence of dust, pollen, mould etc these are inhalable particles, with diameters that are generally 10 micrometres and smaller.[11]

PM10 particles are small particles that can easily get into your throat and lungs. High levels of PM10 can cause cough, nose run and eyes sting. People with heart or lung conditions might have more symptoms when PM10 levels are high also it may cause wheezing, chest tightness or difficulty breathing. PM10 are ultrafine particles with an aerodynamic diameter of less than 1 micrometre. Ultra-fine dust is a major damaging variant of fine particles because the particles enter directly through the lungs into the bloodstream and spread to the organs.[12]

TVOC concentrations of less than 0.3 mg/m3 are considered low. TVOC concentrations of 0.3 to 0.5 mg/m^3 are considered acceptable. The worry is regarded as significant or high after the TVOC concentration level reaches 0.5 mg/m^3. In this study, we can see that 13.3% (28 houses) have the marginal and high concentrations i.e., more than 0.5 mg/m^3.[13]

In rural India, solid fuel is the primary source of energy for cooking, and it is also a common fuel source in urban areas. In Indian households, where women do the majority of the cooking, as well as maintaining the kitchen and raising children, cooking spaces play an essential role. As a result, women are more vulnerable to the negative effects of solid fuels than men. The kitchen contains the largest concentration of particulate matter and toxin proportion, which has been linked to numerous respiratory disorders in women and children.[14-17]

While many people believe that the poor cannot afford to cook and light using clean fuels, the reality is that they do not have access to clean fuels. Inaccessibility to clean cooking fuels is a contributing factor to poverty, ill health, gender inequality, environmental degradation, and air pollution, as well as climate change. Smoke from solid fuel combustion is an important environmental risk factor, accounting for 3.3 per cent of all deaths globally.[18]

Every element of society, with a special focus on socially disadvantaged, marginalised, and rural groups, should have access to clean and efficient cooking fuels. In India, the number of households without access to clean cooking fuel is more than double that of those without access to electricity, negatively impacting not just the health of the people, but also their finances.[19]

The Indian government began the Pradhan Mantri Ujjwal Yojana in 2016 with the goal of connecting 50 million families to LPG by 2019, decreasing pollution-related deaths and illnesses, and assuring women's empowerment, particularly in rural India. The programme had provided 60 million connections as of early January 2019. The scheme's success in terms of attaining health benefits, however, depends not only on the distribution of LPG connections but also on families moving from traditional biomass fuels to modern fuels. LPG cylinders' initial and refill prices have delayed a thorough changeover to modern fuels, which has been a major source of customer concern. Clean energy costs must be reduced by focusing more on research and development of alternative clean energy sources for cooking.[14,15]

Generalising to the entire population is not feasible due to the limited sample size. Therefore, further exploration with a larger sample size is required on this subject.

CONCLUSION

The present study showed that indoor air pollution had a strong relation to socio-cultural factors such as age, poverty and economic level. As women are involved in cooking in the majority of Indian households, they are more prone to be affected by the negative effects of solid fuel usage. Awareness among individuals about the health effects of solid fuel usage such as indoor air pollution is essential to increase their utilization of government efforts of providing LPG connections to every household and reduce the incidences of indoor air pollution. Further research needs to be undertaken to provide alternative clean and affordable energy for domestic purposes.

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Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. World Health Organization. Air pollution. Available from: https://www.who.int/health-topics/air-pollution. Accessed on 5 September 2023.
2. Dakua M, Karmakar R, Barman P. Exposure to indoor air pollution and the cognitive functioning of elderly rural women: a cross-sectional study using LASI data, India. BMC Public Health. 2022;22(1):2272.
3. Tran VV, Park D, Lee YC. Indoor in the Control and Improvement of Indoor Air Quality. Int J Environ Res Public Health. 2020;17(8):2927.
4. Duflo E, Greenstone M, Hanna R. Indoor air pollution, health and economic well-being. SAPIENS Surv Perspect Integrat Environ Soc. 2008;(1.1).
5. Sehgal M, Rizwan SA, Krishnan A. Disease burden due to biomass cooking-fuel-related household air pollution among women in India. Glob Health Act. 2014;7(1):25326.
6. Behera D, Balamugesh T. Indoor air pollution as a risk factor for lung cancer in women. JAPI. 2005;53:190-2.
7. Fullerton DG, Bruce N, Gordon SB. Indoor air pollution from biomass fuel smoke is a major health concern in the developing world. Transact Royal Soc Trop Med Hyg. 2008 ;102(9):843.
8. Pawankar R, Wang JY, Wang IJ, Thien F, Chang YS, Latiff AHA, et al. Asia Pacific Association of

Allergy Asthma and Clinical Immunology White Paper 2020 on climate change, air pollution, and biodiversity in Asia-Pacific and impact on allergic diseases. Asia Pac Allerg. 2020;10(1).

9. Ellegård A, Egneus H. Health effects of charcoal and wood fuel use in low-income households in Lusaka, Zambia. CAB Direct. 1992(14).
10. Nadali A, Arfaeinia H, Asadgol Z, Fahiminia M. Indoor and outdoor concentration of PM10, PM2.5 and PM1 in residential building and evaluation of negative air ions (NAIs) in indoor PM removal. Environ Pollut Bioavail. 2020;32(1).
11. Garg A, Ghosh C. Assessment of indoor air quality at various socio-economic zones. Mapan- J Metrol Soc India. 2022;37(1):15-23.
12. Ibrahim IZ, Chong WT, Yusoff S, Wang CT, Xiang X, Muzammil WK. Evaluation of common indoor air pollutant reduction by a botanical indoor air biofilter system. Indoor Built Environ. 2021;30(1).
13. Becerra JA, Lizana J, Gil M, Barrios-Padura A, Blondeau P, Chacartegui R. Identification of potential indoor air pollutants in schools. J Clean Prod. 2020;242.
14. Gould CF, Urpelainen J, Hopkins SAIS J. The role of education and attitudes in cooking fuel choice: Evidence from two states in India. Energy Sustain Dev. 2020;54.
15. Kumar P, Dover RE, Iriarte ADV, Rao S, Garakani R, Hadingham S, et al. Affordability, accessibility, and awareness in the adoption of liquefied petroleum gas: a case-control study in rural India. Sustain. 2020;12(11).
16. Rahman MM, Begum BA, Hopke PK, Nahar K, Newman J, Thurston GD. Cardiovascular morbidity and mortality associations with biomass-and fossil-fuel-combustion fine-particulate-matter exposures in Dhaka, Bangladesh. Int J Epidemiol. 2021;50(4):1172-83.
17. Krishna B, Balakrishnan K, Siddiqui AR, Begum BA, Bachani D, Brauer M. Tackling the health burden of air pollution in South Asia. BMJ. 2017;359.
18. Austin KF, Mejia MT. Household air pollution as a silent killer: women's status and solid fuel use in developing nations. Popul Environ. 2017;39(1).
19. Rosário Filho NA, Urrutia-Pereira M, D'Amato G, Cecchi L, Ansotegui IJ, Galán C, et al. Air pollution and indoor settings. Vol. 14, World Allerg Organ Journal. 2021;14(1):100499.
20. Kumar R, Goel N, Gupta N, Singh K, Nagar S, Mittal J. Indoor air pollution and respiratory illness in children from rural India: a pilot study. Indian J Chest Dis Allied Sci. 2014;56(2):79-83.

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