Motivational Factors Related to Improving Indoor Air Quality in Rural Nepal

Authors: Hessen, Jens Olav, Schei, Morten A., and Pandey, Mrigendra R.

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Jens Olav Hessen, Morten A. Schei, and Mrigendra R. Pandey

Motivational Factors Related to Improving Indoor Air Quality in Rural Nepal

Sixty-two caregivers in a mountainous region of western Nepal were interviewed about factors related to improving the indoor air quality. The study included 25 households with improved iron stoves and 37 households that cooked on a traditional open fire. In a subsample of 27 households, the field team observed kitchen characteristics and the stoves in everyday use, employing a standardized checklist. All the caregivers with improved stoves expressed satisfaction with their stoves, whereas only 16% of caregivers with traditional stoves were satisfied. There were no differences with respect to time spent in the kitchen or time spent on cooking. The main motivational factors for installing an improved stove were reduced smoke and better health. The villagers were willing to contribute 8% of total annual income per capita to have an improved stove installed. The survey identified weaknesses in stove design that might have influenced the smoke reduction potential of the improved stoves. This paper discusses how local conditions can determine the motivational factors and the success of future programs for improving indoor air quality in this setting.

Keywords: *Indoor air; stoves; motivational factors; household characteristics; developing countries; Nepal.*

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Introduction

The largest indoor concentrations of many important pollutants and the greatest exposure to these pollutants are found in rural areas in the developing world (Chen et al 1990). Eighty-five percent of all human particulate exposure has been estimated to occur indoors, and 80% of this occurs in developing countries (Smith 1993a).

Domestic smoke pollution due to combustion of biomass has been related to serious health effects. Acute respiratory infection (ARI) is a chief cause of death in very young children, and the risk of ARI is significantly higher among children living in households using biomass as their main fuel (Pandey et al 1989). Indoor air pollution has also been connected to adverse pregnancy outcomes, lung cancer, chronic lung diseases, exacerbation of coronary artery disease, and eye problems (Smith 1996). Exposure to suspended particulate matter (SPM) and respirable suspended particulate (RSP) has been estimated to be responsible for about 1.8 million additional deaths per year in rural areas in developing countries (Schwela 1996). Introducing improved stoves significantly reduces exposure and brings considerable health benefits for mothers and children (Smith 1988). The World Health Organization (WHO) has therefore recommended research and action to reduce excessive exposure to indoor air pollution, with a particular focus on developing countries (WHO 1992).

Some studies have shown that installation of improved stoves significantly reduces the level of important indoor air pollutants such as RSP and carbon monoxide (CO) (Smith et al 1993b). Installation of improved stoves is thus considered to be one of the most important measures for reducing indoor air pollution in developing countries. A significant international effort has been devoted to improved stove programs in Nepal and other places in the developing world (Reid et al 1986; Pandey et al 1990). Many of these programs have failed, and studies have been done to find out why they did not succeed (Barnes et al 1993). Because living conditions are different in different parts of the world, generally accepted explanations of success will not necessarily apply to local conditions. The introduction of improved stoves can be facilitated by understanding people's motivation to take an active part in the implementation process and by isolating factors that may determine the success of an implementation program in the local setting.

To prepare for a large-scale study of the potential health benefits from implementation of improved cooking stoves in Nepal, it was important to evaluate motivational factors and kitchen characteristics that might influence the outcomes of such a study. The authors were particularly interested in differences in cooking behavior after introduction of an improved stove and in observing how the improved stoves were actually used in an everyday setting. Since the study aimed to focus on an expected reduction in the number of episodes of acute respiratory infections in the youngest children, it also had to assess differences between the children's exposure time in households with improved stoves and in those with traditional stoves.

Materials and methods

Sixty-two households in 3 villages in the Jumla region (Figure 1), located in the midwestern part of Nepal at an altitude of about 2800 m (Figure 2), were studied. The study area has one of the world's highest incidences of chronic bronchitis and has been the site of a community-based child health project for several years (Pandey 1984). The study took place during a 6-week period in October–November 1995, a season of relative humidity (<30%), with temperatures varying between 20 and 24°C in the daytime and 0 and 6°C at night.

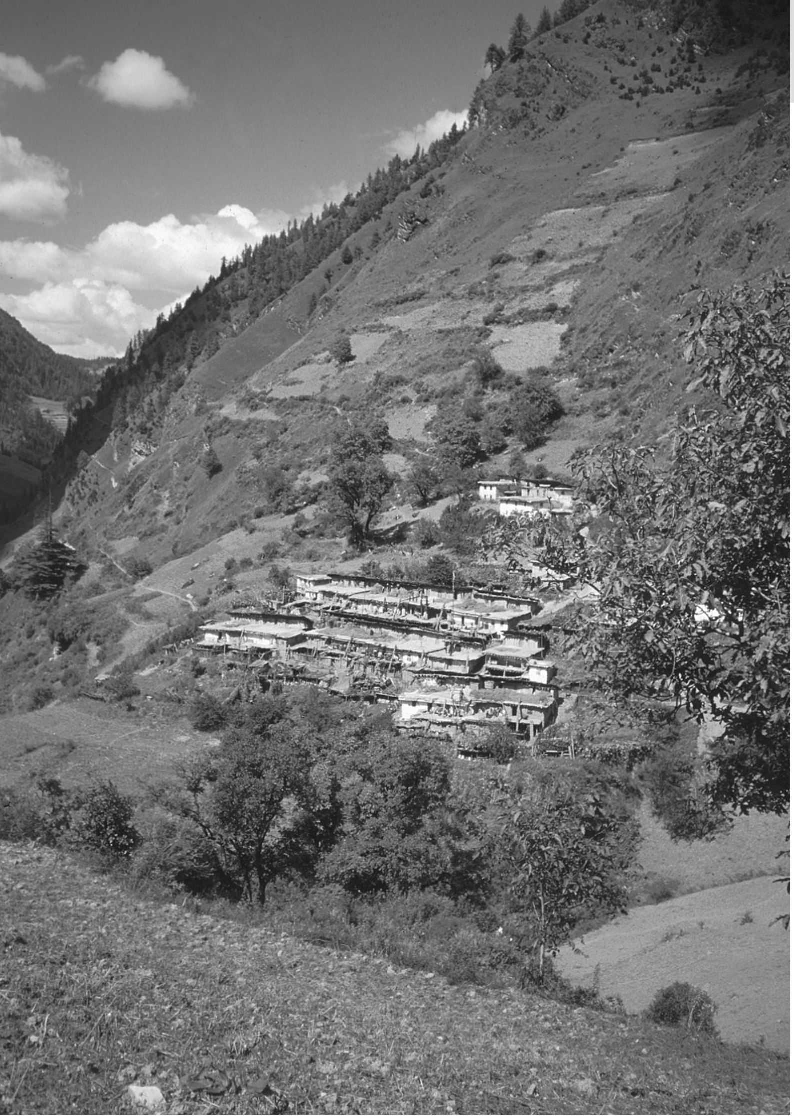

FIGURE 1 Riya, one of the villages in the study area in Jumla District, Nepal. (Photo by Jens Olav Hessen)

Earlier studies in the area showed that the introduction of improved closed-chamber stoves reduced the lighting effect, so households preferred to make a small fire from burning sticks on the top of their stoves. This tradition might contribute significantly to total indoor pollutant levels (Reid et al 1986). Since the introduction of electric lighting in the study area could have changed this practice, the authors selected 3 villages with access to electricity in which all available households with electric lighting were included.

The villages were located within 8 hours' walking distance from the regional center, Jumla Bazaar. The houses were built in rows and made of wood, bamboo, and clay. They were generally small in relation to family size, with 1 or 2 rooms, and the caregivers usually slept on woolen carpets directly on the floor inside the kitchen. All the households earned their livelihood from agriculture, and there were only minor differences in kitchen size, number of rooms, and socioeconomic standards within the same village.

Twenty-five of the households had high-quality iron stoves with flues (improved stoves) and 37 cooked on the traditional open fire on the floor in the middle of the kitchen (traditional stoves). In the study area, the same fire or stove was used both for cooking and for other purposes, such as heating and lighting, but exposure to smoke was also related to smoking of tobacco. The improved stoves had been installed with support from an international nongovernmental organization. This stove program had been halted, yet most of the households with a traditional stove had signed up to have an improved stove installed.

In each household, the person responsible for taking care of the youngest child was interviewed by the same Nepali-speaking health worker, using a standardized questionnaire. The interview included general questions about the age of the caregiver and the youngest child, the number of persons in the household, whether the caregiver smoked or not, and the amount the household would be willing to contribute to have an improved stove installed. The caregivers were asked specifically how many hours they had spent in the kitchen during the last 24 hours, how many hours they had spent on cooking, how many hours they had spent together with the youngest child, and how many hours the child had spent in the kitchen during the same 24-hour period. The caregivers were asked open questions about their motivation for having an improved stove installed. Answers were grouped into main categories prior to data entry.

In one of the villages, in which there were 15 improved and 11 traditional stoves, the same fieldworker made observations in the kitchens according to a standardized checklist. The number of windows and openings in the roof and modifications in the improved stoves were registered. The amounts of visible smoke in the kitchens were classified into one of 4 categories: none, little, some, or much smoke observed.

The questionnaire and the checklist were pretested in the field before the study commenced. The questions and observations are summarized in Tables 1–3.

Statistical analyses were made with the help of Epi-Info software (version 6.02) using frequency tables, chi-square tests (two-tailed Fisher exact test), and nonparametric tests for comparisons of means (Kruskal–Wallis). Ninety-five percent confidence intervals (CIs) of the means are presented.

FIGURE 2 Location of the study area in midwestern Nepal.

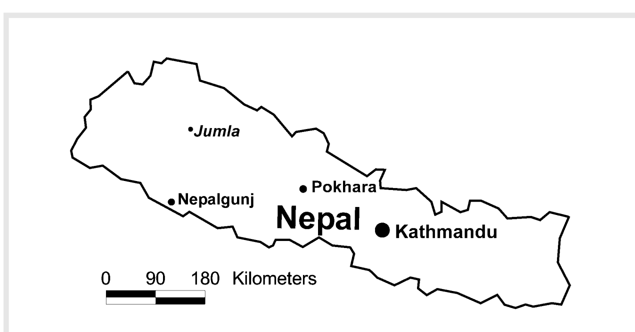

TABLE 1 Selected results comparing household characteristics with improved and traditional stoves (n = 62). Ninety-five percent confidence intervals in parentheses.

Characteristic	Improved iron stove (*n* = 25)	Traditional stove (*n* = 37)	*P*-value (Kruskal–Wallis)
Mean number of persons in the household	8.4 (6.9–9.9)	7.8 (6.6–9.0)	0.46
Mean number of children <16 years	3.7 (3.0–4.4)	3.0 (2.3–3.7)	0.06
Mean age of caregiver	37.9 (32.8–43.0)	36.4 (31.3–41.5)	0.69
Mean age of youngest child (in months)	26.2 (16.3–36.1)	22.8 (14.0–31.6)	0.97

TABLE 2 Mean time spent in the kitchen per day in hours (n = 62). Ninety-five percent confidence intervals in parentheses.

Person/activity	Improved iron stove (*n* = 25)	Traditional stove (*n* = 37)	*P*-value (Kruskal–Wallis)
Principal caregiver			
Total	12.9 (11.3–14.4)	12.8 (11.2–14.5)	0.97
Cooking	5.2 (4.5–5.9)	4.5 (3.9–5.1)	0.26
Youngest child			
Total	9.3 (7.1–11.4)	10.4 (7.7–13.1)	0.66

TABLE 3 Household characteristics related to indoor air quality in the kitchens of a subsample (n = 26). Ninety-five percent confidence intervals in parentheses.

	Improved iron stove (*n* = 15)		Traditional stove (*n* = 11)		
Characteristic	Mean number	Percent	Mean number	Percent	*P*-value (Fisher exact)
Caregivers who smoke	9	60.0 (32.3–83.7)	8	72.7 (39.0–94.0)	0.68
Households where some/much smoke was observed	6	40.0 (16.3–67.7)	11	100 (71.5–100)	0.002
Kitchens without windows	9	60.0 (32.3–83.7)	11	100 (71.5–100)	0.02
Kitchens without a hole in the roof	13	86.7 (59.5–98.3)	7	63.6 (30.8–89.1)	0.35

Results

Table 1 presents a comparison of characteristics of households with improved versus traditional stoves, indicating a higher mean number of children <16 years of age in households with improved stoves ($P = 0.06$). Table 1 indicates no other major differences in the composition of the households.

Table 2 shows no significant difference between the 2 groups in time spent in the kitchen or on cooking. Over a period of 24 hours, caregivers in households with improved stoves spent an average of 15.4 hours (95% CI 12.3–18.5) together with the youngest child. In households with traditional stoves, the mean time spent with the youngest child was 16.2 hours (95% CI 12.0–20.2).

The mean age of the improved stoves was 18.5 months (95% CI 15.1–21.9).

Table 3 presents some differences in household characteristics in the kitchens of one of the villages that may have influenced the levels of indoor pollutants. There was significantly more visible smoke in kitchens with traditional stoves ($P = 0.002$), and there was a significantly greater proportion of households without kitchen windows in the group with traditional stoves ($P = 0.02$). Thirteen (86.7%) of the improved stoves were observed in use with the front door open.

All the caregivers in households with improved stoves (100%) expressed satisfaction with their stoves. In households with traditional stoves, 6 caregivers (16.2%) expressed satisfaction with their stoves. In 23 households (62.1%) in the group with traditional stoves, the caregivers complained about "much smoke" in the kitchen, whereas 23 caregivers with improved stoves (92.0%) reported "less smoke" as a main advantage. "Uses more

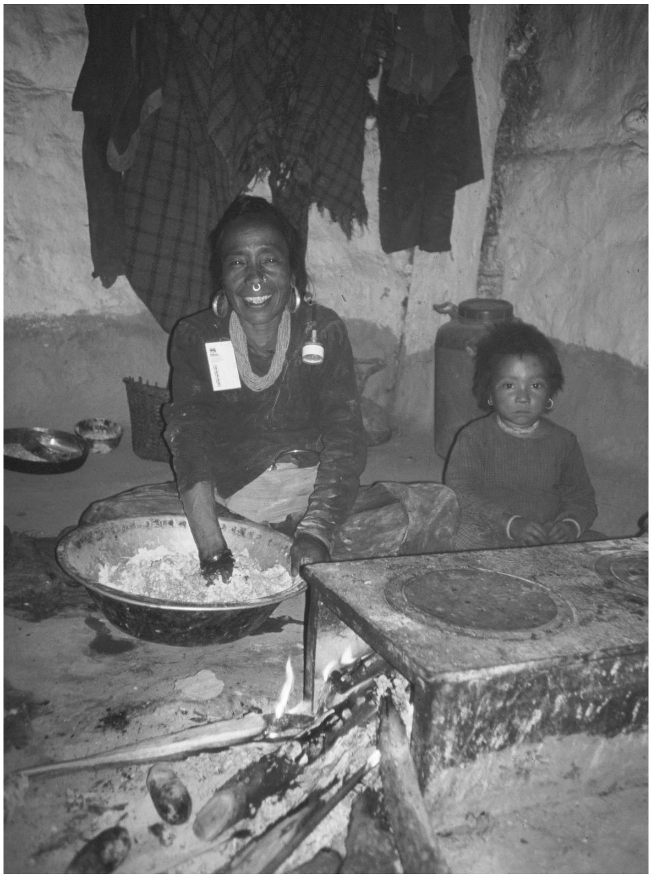

FIGURE 3 Improved iron stove in use by a family in the village of Riya, Nepal. (Photo by Jens Olav Hessen)

firewood" was the major disadvantage mentioned by caregivers with improved stoves (10.3%). Caregivers with traditional stoves reported "less smoke," "health benefits," and "easy to use" as the main motivational factors for changing to an improved stove. Thirty-six (97.3%) of the households with traditional stoves reported an interest in having an improved stove installed.

The mean amount households with traditional stoves were willing to pay to install an improved stove was Rs. 682 (95% CI 458–920), equivalent to US$ 12 in 1995.

Discussion

Our study showed no major differences in the ages of the caregivers and the youngest children or in the total number of persons or children in the 2 different groups of households. Thus, differences between houses with improved and traditional stoves could not be explained by different family composition. The relatively high mean age of the caregivers reflects the fact that grandmothers often had the responsibility for taking care of the youngest children.

There was no significant difference in reported cooking time or time spent inside the kitchen between households with traditional stoves and those with improved stoves. Thus, there seemed to be no major changes in cooking behavior after installation of an improved stove. Smith et al (1983) found no significant differences in fuel efficiency or total cooking time between improved and traditional stoves in India. In an earlier study in Nepal, 35% of the cooks reported a decrease and 38% an increase in cooking time with an improved stove (Reid et al 1986). A study in Guatemala documented that faster cooking was often even more important to the household manager than saving fuel (Tinker 1987). However, a study using the Water Boiling Test (WBT) and Standardized Cooking Test (SCT) showed that, even though the improved stove showed great potential for reducing exposure to indoor air pollutants, the time required to cook water was significantly shorter for the open fire (McCracken and Smith 1998).

There were no differences in total time spent together with the youngest child; hence, exposure to indoor air pollutants could be expected to be the same for the children in the 2 groups. Our findings indicate that monitoring the caregiver's personal exposure to harmful indoor air pollutants could be used as a proxy for assessing the child's personal exposure. A study in Guatemala compared personal exposure to carbon monoxide (CO) of mother and child and reported no significant correlation (Smith et al 1993b). Similar monitoring was performed in Jumla, and preliminary results suggest a strong correlation between CO exposure of the caregiver and the youngest child in the study area (Hessen et al 1996). The time spent in the kitchen by the youngest child was apparently unchanged after installation of the improved stove. Thus, the positive effects from lowering the levels of indoor air pollutants were not reduced by increased total exposure time.

A majority of the caregivers were smokers. In contrast with many other developing countries, studies have shown that the percentage of smokers among women in Nepal is very high (Pandey et al 1988). Tobacco is usually produced locally and smoked in traditional mud pipes. This is potentially an important confounder in studies of personal exposure to important air pollutants. In this setting, a reduction in indoor smoking of tobacco could in itself have a positive effect on indoor air quality.

The improved stoves were constructed and distributed with foreign support in close interaction with the villagers. The original design was a closed-chamber model with higher fuel efficiency. Most of the iron stoves were not used as intended. Eighty-eight percent of the households used firewood that was very long in relation to stove length, and the door at the front of the stove was usually open or removed (Figure 3). This may have increased both fuel consumption and indoor air pollution in a way similar to that shown by a study in Guatemala (McCracken and Smith 1998). There is also a problem of maintenance in areas without access to tools and replacement parts. As a consequence, some of the kitchens in our study with "smokeless" stoves had considerable amounts of visible smoke inside.

Poor ventilation is known to worsen the indoor environment, partly because the level of indoor smoke pollution increases. None of the houses with traditional stoves had windows, and only one third had a hole in the roof. Thus, in the households with improved stoves, better ventilation might have influenced the perceived improvements in smokiness. The improved stoves gave less firelight in the room, and this could partly explain the need for more windows. However, with a reduced level of indoor air pollution, the windows could be closed more often to improve heat retention, thus lowering the need for heating fuel. Since most of the improved stoves had been installed very recently, the differences in ventilation probably did not reflect changes after the installation of stoves. These findings could reflect minor differences in income and socioeconomic status. At the same time, the existence of windows in 40% of the kitchens with improved stoves indicates a potential for more windows and thus possible local acceptance of improved ventilation in other houses as well.

We found that villagers with traditional stoves were very motivated to have stoves that can reduce the level of indoor air pollutants. Those who already had an improved stove in their kitchens were highly satisfied. This corresponds to earlier findings from Nepal, which showed that all owners of improved stoves found them to be more convenient than their previous stove (Reid et al 1986). In another study, 5 out of 20 cooks interviewed did not like their new stoves (Pandey et al 1990). This was partly explained by the local tradition of producing liquor using a pot that did not fit properly to the stove. Several households in this other study used a separate fire for heating in the cold season. In these households, an improved stove for cooking would only partly influence the total smoke exposure and could maybe more easily be felt to be an additional burden for the household. However, in the Jumla region, the same stove was used for heating, lighting, and cooking. It was designed to improve fuel economy but the villagers modified it to make it fit their everyday needs; this included lighting a small fire on top of the stove to improve lighting. This indicates the importance of studying local traditions to design improved stoves that are acceptable in an everyday setting.

The main motivational factors for installing an improved stove were largely related to smoke-reduction potential. Better health was mentioned specifically by many of the caregivers. This may have been influenced by the focus on preventive medicine, including reduction of indoor air pollution in the study area. However, the caregivers seemed to be aware of the health benefits of improved stoves. This impression was supported by the fact that almost all the caregivers reported having experienced reduced indoor smoke pollution after installation of an improved stove. The cooks in Reid's study preferred improved stoves mainly because of the benefits from less smoke in the kitchen, that is, better health, comfort, and improved sanitation (Reid et al 1986). Ninety-six percent of the cooks perceived a reduction in smoke with improved stoves. In all cases but one, Pandey reported that women experienced less smoke in the kitchen when cooking with the new stove as opposed to the traditional stove (Pandey et al 1990).

Earlier studies have pointed out several characteristics shared by successful stove implementation programs (Barnes et al 1993). The most successful programs have been run in areas where fuelwood prices and collection times were high. In parts of Nepal, the problems of deforestation and erosion of productive land are significant. Yet, in most parts of the Jumla region, wood was easily collected close to the villages. Thus, this factor was far less important in this area than in other parts of the world.

Reid reported that fuel saving was of secondary importance in the preference for improved stoves (Reid et al 1986). Some of the caregivers with improved stoves complained about an increase in wood consumption after having the improved stove installed. This cannot be explained by the tendency to overestimate fuel consumption (Fox 1984) as long as the caregivers could compare directly with earlier consumption in the household. Since the stoves were also used for lighting and heating, more efficient combustion could have resulted in higher total fuel consumption because the time the stove was lit would be the same in the 2 groups.

Annual income per capita in 1990 was US $150 for over 80% of the population in the hilly area of Nepal (Ali 1991). Thus, villagers were willing to pay an amount equivalent to approximately 8% of their annual income, which would cover about 20% of the costs of an iron stove. This might have reflected the fact that people understated their willingness because they hoped that researchers might provide them with a stove. However, many of the households had already signed up to have an improved stove installed before the research team arrived. Thus, there appeared to be strong local motivation to improve indoor environments. In programs that initially offer stoves at no cost, the stoves are often not used and maintained as intended (Barnes et al 1993). An economic contribution by the villagers themselves to a stove implementation program could increase awareness about the importance of maintenance and actual use of the stoves.

Conclusions

The present study identified motivational factors and household characteristics to be taken into consideration when designing an intervention study on the health effects of reducing indoor air pollution in Nepal. The findings reflect the complexity and challenges related to reducing smoke exposures from a public health perspective. Many stove intervention programs have focused on environmental aspects, and the stoves have been designed mainly to reduce fuelwood consumption, an argument more readily perceived by the villagers. Health benefits other than improved comfort are often difficult to perceive because they are not immediate results and therefore are more difficult to argue. But because the study area had been the site of a community-based child health project for several years, the villagers had a clear idea of the positive effects on child mortality of reducing the number of severe ARI attacks. The villagers were informed that less smoke in itself could reduce ARI mortality. This might partly explain the strong local motivation to opt for an improved stove. The study therefore exemplifies the importance of integrating health programs into traditional stove implementation programs. Considering the importance of health benefits from reducing smoke exposure in these settings, even programs concluding that fuel consumption increased could be regarded as successful from a public health perspective.

The most successful rural development projects have often relied on participatory processes. In areas where household economies have been improved, men tend to give less priority to improving the kitchen environment that is traditionally the women's world. Including the argument of health benefits from reducing indoor air pollution may be one way of overcoming this negative effect of gender bias. Estimates are that a reduction in average global RSP exposure to the maximum level recommended in the WHO guidelines might reduce mortality worldwide by 3.5% (Smith 1996). Thus, efforts to improve indoor air quality in rural areas in developing countries would have major implications for global public health.

AUTHORS

Jens Olav Hessen
Institute of Community Medicine, Medical Faculty, University of Tromsø, 9037 Tromsø, Norway.
jens.olav.hessen@stsh.no

Morten A. Schei
Environmental Health Sciences, School of Public Health, University of California, 140 Warren Hall, Berkeley, CA 94720-7360, USA.
mschei@uclink.berkeley.edu

Mrigendra R. Pandey
Mrigendra Samjhana Medical Trust, PO Box 2587, Kathmandu, Nepal.
msmt@healthnet.org.np

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