

Shift work and health

Shift work — employment with anything other than a regular daytime work schedule — makes up a large part of work in the Canadian economy.

For at least 50 years, researchers have been exploring the question of whether working shifts poses a health hazard. This note summarizes the findings of a selection of this research, including several articles that have reviewed aspects of this literature.

Following the approach taken by Williams (2008), one can identify the following categories of shift work:

- regular evening schedules (beginning after 3 p.m., ending before midnight),
- regular night (beginning after 11 p.m., ending before 11 a.m.),
- rotating (day to evening and/or night),
- split (two or more distinct work periods each day),
- on call (no pre-arranged schedule), and
- irregular shifts.

Williams, using data from Statistics Canada's *General Social Survey*, found that 25.5 per cent of full-time workers, aged 19-64, worked shifts in 2005. About 45 per cent of health-care workers and 66 per cent of those in protective services (police, security guards) were shift workers, but so were 40 per cent of those in sales and service, and 42 per cent of those in occupations unique to primary industries such as agriculture, forestry and mining. The most common forms of shift work were rotating schedules (accounting for 36.3 per cent of shift work in 2005) and irregular shifts (31.4 per cent). Figures for regular evening and regular night shifts were 11.5 and 8.1, respectively. The overall percentage of full-time workers who work shifts has not changed much since the early 1990s: it was 22.2 in 1992, 27.6 in 1998 and 25.5 in 2005.

Theoretical Considerations

Disruption of the body's circadian rhythms is thought to be the main pathway for adverse health effects from shift work, particularly for work schedules that include night work. Circadian rhythms are the body's biological cycles that recur at 24-hour intervals, including sleep-wake patterns, body temperatures and hormone levels.

KEY MESSAGES

- People who work night shifts are likely to have shorter sleep duration and/or poorer sleep quality than regular day workers.
- Long-term exposure to night shift work may elevate the risk of breast cancer. There are also findings pointing to an elevated risk of colorectal cancer.
- Some studies indicate an elevated risk of preterm delivery, gastrointestinal disorders and mental health problems among shift workers.
- Research findings regarding a causal link between shift work and heart disease are inconsistent.
- Shift workers, especially those working at night, face a higher risk of workplace injury than regular day workers.
- Promising approaches to mitigate the adverse effects of shift work include restricting successive evening or night shifts to three shifts, limiting weekend work, moving from backward to forward shift rotation and using a participatory approach to the design of shift schedules.
- More research is needed to resolve some of the questions regarding the health effects of shift work, and to investigate the impact of interventions designed to mitigate the adverse consequences of shift work on health.

Haus and Smolensky (2006) reviewed several possible effects of a disruption in circadian rhythms on shift workers. It can result in insomnia or non-restorative sleep during the period of adjustment to a new schedule. It can also lead to changes in hormone levels, which can influence cell growth and division. Moreover, workers rarely become completely habituated to unusual shifts. Even after a long time on night shifts, only a minority of workers show adaptation of their circadian system to the nocturnal activity pattern, in part because night workers usually revert to the usual sleep/wake cycle on days off.



Shift work can also have adverse health effects through its potential impact on behaviour, such as poorer quality diet, or increased smoking or alcohol consumption. Bøggild and Knutsson (1999) reported that shift workers are more likely than regular day workers to be smokers.

Finally, shift work may disrupt social and family relationships, by putting the worker's daily pattern of work and rest out of phase with that of family, friends and the social life of the community. This social disruption can also contribute to stress and thereby to adverse health outcomes.

Overview of possible health effects

Costa (2003) cited research findings that indicate that shift work (particularly, night work) can lead in the short term to sleep difficulties, digestive problems and anxiety. In the longer term, it can lead to gastrointestinal and cardiovascular diseases, and pregnancy complications. Costa's article was one of five on shift work and health in the same issue of *Occupational Medicine*. Stevens (1987) and Stevens and Rea (2001) have postulated and studied a possible link between shift work and breast cancer. Shields (2002) cited research suggesting an elevated risk of breast cancer, asthma, diabetes and epilepsy for shift workers.

In the rest of this *Issue Briefing*, we look at research findings regarding possible links between shift work and the following health problems that seem to be most commonly cited in the literature:

- sleep disorders,
- workplace injury,
- cancer,
- pregnancy complications,
- gastrointestinal disorders,
- cardiovascular disease,
- psychological distress,
- diabetes.

We also examine the more limited literature on what might be done to mitigate the adverse consequences of shift work on health.

In interpreting the research, it is important to keep in mind the possibility of biases from "selection," of three kinds:

- 1) Those most likely to be susceptible to health effects from shift work may be less likely to do such work.
- 2) Those who develop health problems may drop out of a shift work schedule early.
- 3) Shift workers could have worse health prior to beginning a shift schedule, associated with their typically lower socio-economic status.

The first two possibilities would tend to lessen the measured association between shift work and health. The third

would tend to increase it. These considerations speak to the importance of accounting for the initial health status of the workers, and then following them over time after they begin a shift schedule.

The importance of accounting for the possibility of selection is illustrated in one of the earliest studies on shift work and health, namely that by Aanonsen (1959). He compared medical records of men in 1952 at three factories (two electrometallurgical; one electrochemical) in western Norway. Aanonsen identified three groups: 345 day workers who had never worked shifts; 380 who worked mainly on a shift schedule; and 350 who had been working shifts but had since moved into day work. There was little difference between the first two groups in the frequency of nervous, digestive system or heart disorders. Shift workers had a lower frequency of work absence than the day workers. However, among the third group, those who had been on shift work and later transferred to day work, there was a marked elevation in the incidence of nervous and digestive disorders (though not of heart disease).

It is also important to recognize that the effects of shift work on health could be mediated through its impact on other factors, such as smoking or alcohol consumption. For example, working a shift schedule could lead to elevated stress, and in turn could lead to higher rates of tobacco smoking or alcohol consumption, which could have adverse health impacts.

Shift work and sleep

Numerous studies, including an early literature review on shift work and health by Rutenfranz et al. (1977), have reported findings of sleep disruption associated with shift work that includes night shifts. Sleep disruption includes reduced sleep duration and/or sleep quality.

In a 2003 review of research on the effects of shift work on sleep, Åkerstedt also concluded that shift workers experience more sleep disturbances than day workers. Night shift workers will be trying to sleep when the circadian pattern promotes alertness, which interferes with and truncates sleep. Night shift workers are also more likely than regular day workers to experience sleepiness during their work shift, particularly in the early morning, because work is occurring at a low point in the circadian pattern. "[A]lertness, performance and metabolism peak in the late afternoon and reach a nadir in the early morning," Åkerstedt noted. Some research indicates that napping during the shift helps to restore alertness.

Åkerstedt reported that the sleep pattern before an early morning shift, beginning around 6 a.m., is even more disrupted and shortened, due in part to the early rising time of 4 to 5 a.m. This also leads to increased sleepiness during the day.

Ursin et al. (2005) looked at data for 7,782 participants in a Norwegian survey conducted during 1997-1999, and found that shift workers reported shorter sleep duration than day workers.

The connection between shift work and sleep difficulties is recognized in the *Diagnostic and Statistical Manual of Mental Disorders*, which lists shift work sleep disorders as a sub-category of circadian rhythm sleep disorders.

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Workplace injury

Folkard and Tucker (2003) reviewed the literature on the relationship between shift work and work safety. (They also looked at productivity.) They emphasized that studies of this relationship need to account for two possibilities: different exposure to risks on different shifts, and different injury reporting patterns for night workers than others. When such influences have been controlled for, the following trends emerged:

- The risk of “incidents” (defined as “accidents and injuries”) is higher for afternoon shift work than for those on a morning shift, and higher still for night shifts.
- The risk of incidents rises about 20 per cent from the first to the second hour of the night shift, but then falls steadily, except for an upward blip between 3 a.m. and 4 a.m.
- Incident rates increase on successive night shifts: on average, the incident rate on the fourth night is 36 per cent higher than on the first night. (There is a much smaller increase in incident rates over successive morning or day shifts.)
- The risk of an incident increases markedly after more than eight hours on duty: the risk in the 12th hour is almost double than in the eighth hour (and more than double the average risk over the first eight hours on duty).

Dembe et al. (2006) used data from the *National Longitudinal Survey of Youth* in the United States to examine the effects of different types of shift work on the combined incidence of work injury and illness, per year worked. They looked at the work experience of people in each year between 1987 through 2000, except 1991. Workers were between the ages of 22 and 30 at the start of the study. Controlling for age, gender,

occupation, industry and region (but not educational attainment or prior health status), Dembe et al. found that night, evening, rotating and irregular shifts all were associated with an increased risk of occupational injury or illness compared with regular day shifts. The risk was elevated by 43 per cent for evening shift workers, 36 per cent for those working rotating shifts, and 30 per cent for night shift workers.

Cancer

One hypothesis that has emerged in the literature is that working at night might increase the risk of cancer because of disrupted melatonin levels, which affects tumour growth. Melatonin secretion is normally at its peak at night, but production of this hormone is reduced as a result of light exposure during night hours (Stevens, 1987; Stevens and Rea, 2001). Results from experimental studies on rodents (such as that by Blask et al., 2002) support a link between melatonin and tumour suppression, especially for breast tumours.

Schernhammer and Hankinson (2003) reviewed the research on the link between exposure to light at night and breast cancer in shift workers. They concluded that, “Observational studies provide fairly consistent evidence for a modest positive relation between different measures of light exposure at night and breast cancer risk.” Examples of the research that they cited include the following:

- A Finnish study (Pukkala, Auvinen and Wahlberg, 1995) reported a significantly higher incidence of breast cancer in female flight attendants who had been working in the airline industry for 15 years or more. This study hypothesized that exposure to ionizing radiation was the cause, but others have pointed to the exposure to light at abnormal times as the possible source. Similar findings were reported in a study of female flight attendants in Iceland (Rafnsson et al., 2001). A Norwegian study (Tynes et al., 1996) of female radio and telegraph operators with potential exposure to light at night also found an elevated risk of breast cancer. However, these studies contained only a few controls for other possible causes of breast cancer.
- Schernhammer et al. (2001) evaluated data from the *Nurses’ Health Study* in the U.S. on 78,562 nurses who worked on rotating night shifts (at least three nights per month in addition to day or evening shifts that month). Participants were asked in 1988 how many years they had worked on a rotating night shift and then were followed over the next 10 years to identify incident breast cancer. (Those who reported cancer in 1988 or previously were excluded.) Researchers controlled for a number of established breast cancer risk factors such as age, menopausal status, number of children,

body mass index and family history of breast cancer. Relative to those who had no history of night shift work, women who worked 1-29 years on rotating night shifts had a risk of developing breast cancer that was eight per cent higher. For those working 30 or more years on night shifts, the risk was 36 per cent higher.

- In a study of another cohort of nurses in the U.S., Schernhammer et al. (2006) found that those with more than 20 years of work in rotating night shifts had a 79 per cent higher risk of developing breast cancer than nurses who did not work nights.

Schernhammer et al. (2003) also analyzed data from the *Nurses' Health Study* regarding the incidence of colorectal cancer. They found evidence of elevated risk of colorectal cancer for female nurses who had been on rotating night shifts for 15 years or more.

Kubo et al. (2006) looked at the incidence of prostate cancer among 14,052 working men in Japan who were initially interviewed between 1988 and 1990, and then followed up until the end of 1997. After adjustment for other factors that may affect cancer risk, the authors found that those working rotating shifts had a significantly higher risk of prostate cancer than day workers, but there was no significant increase in risk for those on fixed night shifts. The authors suggested that rotating shift workers may experience greater disruption in circadian rhythms.

“shift work that involves circadian disruption is probably carcinogenic to humans”

Kayumov et al. (2005) noted that night exposure to light of short wavelength suppressed melatonin secretion. They looked at the effect of wearing goggles that filtered out light of short wavelength. In a study of 19 healthy young men and women, they found that wearing these goggles at night preserved melatonin levels and did not impair performance or alertness.

A study by Travis et al. (2004) cast some doubt on the possible link between melatonin levels and breast cancer. They examined melatonin levels in women on the island of Guernsey who were cancer-free when recruited into the study between 1977 and 1985, but who had developed breast cancer by 2001. The analysis involved matching the case patients with control subjects who had not developed breast cancer at the time the case patient was diagnosed. The case and control subjects were also matched on criteria such as age and menopausal

status. The statistical analysis adjusted for other factors that may affect the relationship between melatonin levels and breast cancer, such as family history of breast cancer and use of medication thought to influence melatonin production. They found no significant relationship between melatonin and the risk of breast cancer for either pre- or post-menopausal women. However, the authors noted that the sample size in their study was fairly small (127 case patients and about three control subjects for each case patient) and they could not rule out a moderate association between melatonin levels and breast cancer. They also noted that it is possible that the pattern of melatonin secretion over the course of the day, rather than the total quantity produced, affects the risk of breast cancer.

On the basis of “limited evidence in humans for the carcinogenicity of shift work that involves night work” and “sufficient evidence in experimental animals for the carcinogenicity of light during the daily dark period (biological night),” an expert Working Group convened in 2007 by the International Agency for Research on Cancer (IARC) concluded that “shift work that involves circadian disruption is probably carcinogenic to humans” (Straif et al., 2007, p.1065).

Pregnancy complications

Bonzini, Coggon, and Palmer (2007) conducted a systematic review of the literature on the association between several possible pregnancy complications (premature delivery; low birth weight; and pre-eclampsia) and various working conditions, including shift work or night work, which were grouped together. (Pre-eclampsia is characterized by high blood pressure and excessive weight gain, among other symptoms.) There were only two studies in each case on the relationship between shift/night work and low birth weight or pre-eclampsia, pointing to “no more than a moderate effect” (p.241, Table 6). Regarding shift work and preterm delivery, Bonzini et al. concluded that the balance of evidence suggested a small effect. For the eight studies that met their criteria for higher quality, the pooled estimates indicated a 26 per cent increased risk of preterm delivery for shift/night workers than day workers. Bonzini et al. grouped all types of shift work together, which means that it is possible that risk ratios differ for the various types of shift work.

Gastrointestinal disorders

Rutenfranz et al. (1977) noted that “gastric and intestinal dysfunctions predominate in shift workers.” They also cited findings of increased tobacco smoking and caffeine consumption by those who work at night.

In a review of various health disorders and shift work, Knutsson (2003) concluded the strongest evidence supported an association between shift work and gastrointestinal disease, coronary heart disease and pregnancy complications (miscarriage, low birth weight and preterm birth). He cited several studies reporting more gastrointestinal disorders among shift workers than day workers. For example, a Japanese study (Segawa et al., 1987) of 11,675 employees in factories, banks and schools found that gastric ulcers were more than twice as common among shift workers than day workers.

Heart disease

Rutenfranz et al. (1977) concluded that “the incidence of cardiovascular disease and nervous symptoms does not seem to be higher than in the population at large.” However, since then there has been considerable research on the subject. The *Scandinavian Journal of Work, Environment & Health* has published reviews of the literature on shift work and heart disease on three occasions, each a decade apart.

- Kristensen (1989) concluded that shift workers have a 40 per cent higher risk of heart disease compared with regular day workers – that is, a relative risk of 1.4 — based on the findings of the higher quality studies.
- Bøggild and Knutsson (1999), in their review of 17 studies, came to the same conclusion as Kristensen (1989). They reported a wide range of findings, with a risk ranging from 60 per cent lower to 260 per cent higher (relative risks were 0.4 to 3.6, with most estimates between 1 and 2). Most of the larger and more methodologically sound studies found a 40 per cent higher risk of cardiovascular disease among shift workers, but four relatively large studies found no association. Bøggild and Knutsson concluded that the relative risk of 1.4 seems to be the “most reasonable risk estimate.”
- Frost, Kolstad and Bonde (2009), in a systematic review, examined 14 articles, including two from the two previous reviews. They found that “relative risk estimates varied from 0.64 to 2.25 [36 per cent decrease in risk to 125 per cent increase], with most estimates around unity.” They concluded that there was “limited evidence of a causal association between shift work and ischemic heart disease.” They raised methodological concerns about all of the studies, including possible selection bias, problems of lumping different types of shift work together, inadequate controls for other influences on heart disease and failure to look at the duration of exposure.
- Bøggild et al. (2001) re-analyzed data from 1990 on 5,940 employees from the Danish Work Environment Cohort Study, which involved a random sample of Danish employees. They

found indirect evidence of a connection with heart disease: male shift workers were more likely than day workers to report higher exposure to various working conditions that have been found to be related to heart disease, such as noise, heat, passive smoking, monotonous tasks, low decision latitude.

Psychological distress

Jamal (2004), drawing on a cross-sectional study of 376 full-time workers in a Canadian city, noted that shift workers report significantly higher burnout, emotional exhaustion, job stress and psychosomatic health problems (such as headaches, upset stomach, difficulty falling asleep) than workers on a regular day schedule.

Haines et al. (2008) cited several studies that pointed to an association between shift work and “psychological distress, depression, anxiety and burnout.” Their study focused on the possibility of work-family conflict: that shift work may interfere with participation in family life, because of both scheduling and fatigue, which may increase the risk of depression. Haines et al. analyzed data collected between January 2004 and March 2005 for the Canadian component of an international study on gender, alcohol and culture. Only those who were married or cohabiting, had a least one child at home, and were working at least 20 hours a week in a paid job were included, yielding 2,931 cases. They compared those working a regular daytime schedule with those working any other schedule (which is not ideal, in light of marked differences possible in types of shift work schedules). They first investigated factors affecting the degree of work-to-family conflict, assessed by a 3-item scale). Then they analyzed factors that might cause major depression, based on interview responses, during the previous 12 months. They controlled for variables such as type of work contract (self-employed or salaried), hours worked, gender, age, educational attainment, whether or not spouse/partner had paid employment, number of children and age of youngest child. In the first model, Haines et al. found a significant positive association between shift work and work-family conflict; in the second, work-to-family conflict was found to significantly raise the likelihood of depression. In the latter model, shift work also raised the risk of depression, suggesting that its interference with family life does not fully mediate the effect of shift work on depression. Haines et al. estimated that about 70 per cent of this effect is direct, and 30 per cent mediated through work-to-family conflict. Other mechanisms, such as social isolation, could be involved.

Bara and Arber (2009) used longitudinal data from the *British Household Panel Survey* to examine the effects of shift

work on mental health. Survey participants reported the number of years between 1995 and 2005 that they worked night shifts or a schedule with varied shift patterns. Mental health was assessed in two ways: through responses to the General Health Questionnaire and through a question about the presence of problems with anxiety or “depression or bad nerves” or “psychiatric problems” (Bara and Arber 2009, p.363). They controlled for age, marital status, education, occupation and baseline mental health, measured through self-reported anxiety or depression in the first year of available data. They found that men who had worked nights for four or more years were more than twice as likely as men who had never worked nights to report mental health problems (through either measure). However, working varied shifts did not have a significant impact on men’s mental health. For women, the results were almost the inverse of those for men: those working varied shifts for four or more years—two years for the anxiety/depression measure—were more than twice as likely to report mental health problems than women who did not work varied shifts, but night work did not have a significant impact.

Diabetes

Suwazono et al. (2006) evaluated the relationship between shift work and the onset of diabetes among male workers in a Japanese steel company. They used records from the participants’ medical examinations over the period 1991 to 2001. Those who had diabetes or certain other conditions before the start of the study were excluded, and other variables that could affect the risk of diabetes were controlled for in the statistical analysis. Suwazono et al. found that the risk of developing diabetes was significantly higher for workers on rotating shifts than it was for regular day workers.

Mitigating adverse effects

Bøggild and Jeppesen (2001) evaluated cholesterol levels among nurses and nurses’ aides engaged in rotating shift work at four hospital wards in the county of Northern Jutland, Denmark. Through a participatory approach, agreements were made at the four wards to change the shift scheduling system so as to respect one or more of the following:

- Maximum of three or four consecutive night shifts followed by an extra day off (all four wards).
- More regular and predictable (but somewhat less flexible) schedules (three wards).
- Going from three different shift types to two (three wards).
- Increasing the number of weekends off (two wards).

Six other wards, plus staff at the intervention wards who chose not to change schedules, served as controls.

Cholesterol measures, as markers of the risk of heart disease, were taken before and six months after the change in shift schedules. For those whose new schedules reflected all four principles outlined above, there were favourable changes in the cholesterol measures relative to the control group.

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Knauth and Hornberger (2003) outlined 20 recommendations to prevent or mitigate negative health outcomes of shift work, based on their assessment of the implications of existing research. These recommendations include:

- restricting successive evening or night shifts to three shifts;
- avoiding permanent night work;
- using forward or clockwise rotation in rotating systems, (morning to evening to night rather than backward or counterclockwise rotation);
- providing adequate resting time (greater than 11 hours) between shifts; and
- limiting weekend work.

(Some of these recommendations are also found in the 2006 paper by Haus and Smolensky).

However, Knauth and Hornberger noted that few studies have evaluated the effects of implementing such guidelines for shift workers, and that the studies that do exist show only limited effects. They suggested that the approach has to be tailored to the specific work context. In addition, there is evidence for gains from designing the shift system in a participatory way, with engagement of workers, unions, supervisors, etc., and with monitoring and evaluation of impacts.

Bambra et al. (2008) conducted a systematic review of studies that evaluated the impact on health and work-life balance of organizational-level interventions to modify shift work schedules. Researchers found beneficial effects from three types of interventions.

- Increasing the speed of shift rotation was associated with improved sleep and reduced fatigue (for example, from seven consecutive morning shifts to a maximum of three or four consecutive shifts of the same type).

- Changing from backward to forward rotation also led to improved sleep.
- Self-scheduling—the opportunity for “individual shift workers to have some control over which shifts they work, when they start work or when their rest days occur” (Bambra et al. 2008, p.431)—was associated with decreases in work absence, less fatigue, improved work-life balance and improvements in productivity.
However, Bambra et al. noted that there are few high quality intervention studies in this area.

Conclusion

There is a relatively large literature on possible connections between shift work and several aspects of worker health. In some of these areas, the research findings clearly point to an elevated risk of adverse health outcomes arising from shift work. In other areas, the research is less conclusive.

- There is little dispute that people who work night shifts are likely to have shorter sleep duration and/or poorer sleep quality than regular day workers. There is also some indication of sleep disruption for those who work shifts that begin in the early morning.
- The risk of workplace injury appears to be higher for afternoon shift work than on a morning shift, and higher still for night shifts. The risk of incidents is particularly high in the second hour of a night shift.
- An expert Working Group of the International Agency for Research on Cancer (IARC) has concluded that “shift work that involves circadian disruption is probably carcinogenic to humans.”

- There are several studies, in each case, that point to:
 - a modestly elevated risk of preterm delivery for shift workers;
 - an elevated risk of gastrointestinal disorders; and
 - an association between shift work and mental health disorders including depression.
- While past review studies had concluded that there was evidence of a causal link between shift work and heart disease, the most recent review of this literature finds only limited evidence of this link.

Guidelines have been proposed—examples are given in the section on mitigating adverse effects—to counter health risks facing shift workers. However, there appear to have been few studies of high quality that evaluate the effects of implementing such guidelines. Among those that exist, there are findings of positive effects on sleep, fatigue, and/or work-life balance of interventions to increase the speed of shift rotation, move from backward to forward rotation, or increase the ability of individuals to design their shift schedules.

These findings suggest that we still need more high quality studies to resolve some of the questions regarding the health effects of shift work, such as the possible link to heart disease and the possible role that hormone levels play in the connection between shift work and cancer risk. In particular, we need more studies that distinguish the different types of shift work, that examine the relative impact of different lengths of time spent on a shift work schedule, and that explore the question of whether some individuals are more susceptible than others to negative effects of shift work. We also need more research on the impact of interventions designed to mitigate the adverse consequences of shift work on health. That will require partnerships between workplaces and researchers in testing the potential benefits associated with different interventions.

Issue Briefings summarize, in plain language, research findings on topics expected to be of current interest to the policy community. Where appropriate, they also explore the policy implications of the research. Issue Briefings are designed to give readers a quick overview of key findings on a topic, and to stimulate a continuing conversation on the issues. While they do not attempt to be systematic or comprehensive in their review of the relevant literature, they do pay attention to the quality of the research. They also consider existing reviews of the literature when available. IWH does conduct reviews of literature that are more comprehensive and/or

systematic, but these are also necessarily more time-consuming to produce.

A “systematic review” is a literature review that focuses on a single question by identifying, appraising and summarizing the results of primary research. Systematic reviews are designed to minimize bias by using replicable, scientific and transparent approaches. They often involve a team of reviewers to select relevant studies, assess them for the quality of their research methods, and analyze the strength of the evidence based upon the number of studies of good quality with similar conclusions (and whether there are opposing findings in other quality studies).

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