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Effects of mental demands during dispensing on perceived medication safety and employee well being: A study of workload in pediatric hospital pharmacies

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Abstract

Background—Pharmacy workload is a modifiable work system factor believed to affect both medication safety outcomes and employee outcomes such as job satisfaction.

Objectives—This study sought to measure the effect of workload on safety and employee outcomes in two pediatric hospitals and to do so using a novel approach to pharmacy workload measurement.

Methods—Rather than measuring prescription volume or other similar indicators, this study measured the type and intensity of mental demands experienced during the medication dispensing tasks. The effects of external (interruptions, divided attention, rushing) and internal (concentration, effort) task demands on perceived medication error likelihood, adverse drug event likelihood, job dissatisfaction, and burnout were statistically estimated using multiple linear and logistic regression.

Results—Pharmacists and pharmacy technicians reported high levels of external and internal mental demands during dispensing. The study supported the hypothesis that external demands (interruptions, divided attention, rushing) negatively impacted medication safety and employee well being outcomes. However, as hypothesized, increasing levels of internal demands (concentration and effort) were not associated with greater perceived likelihood of error, adverse drug events, or burnout, and even had a positive effect on job satisfaction.

Conclusion—Replicating a prior study in nursing, this study shows that new conceptualizations and measures of workload can generate important new findings about both detrimental and beneficial effects of workload on patient safety and employee well being. This study discusses what those findings imply for policy, management, and design concerning automation, cognition, and staffing.

Keywords

Workload; mental demands; medication error; safety; employee well being; human factors

Human factors[a] specialists and the pharmacy community have a common goal to improve clinical work systems in order to achieve acceptable levels of medication safety and employee well being.[1–5] Principled work system improvement is especially needed in hospitals, where high rates of medication dispensing errors[6–8] and adverse drug events[9] have been documented. Medication safety in pediatric hospitals, particularly, has received some, but perhaps insufficient attention.[10, 11] Pharmacy work in pediatric hospitals is complicated by weight-based dosing, patients' susceptibility to drug-related harm, and other conditions specific to pediatric patient populations (e.g., difficulty communicating).[12, 13] In the matter of employee well being, recent quality of working life studies have been carried out to measure job stress, job dissatisfaction, and burnout experienced by pharmacists and pharmacy technicians. Some of those studies show that hospital pharmacists and technicians have poor working conditions compared to pharmacy workers in other settings.[4, 14–17] However, many of those studies also report that hospital pharmacists are generally satisfied and are more satisfied than chain pharmacists.[4, 14–16, 18–20]

Workload is one of many pharmacy work system factors that may influence both patient and employee outcomes. Workload, broadly defined, appears to affect medication safety in pharmacies[6, 21–29] as well as pharmacy employee outcomes such as job satisfaction, although there is only limited research on employee outcome effects.[30–33] However, "workload" is defined and measured differently across studies. Most commonly, workload is treated in terms of volume—i.e., the number of prescriptions dispensed[28, 34–37]—or, more commonly, in terms of intensity—i.e., volume per some amount of time and/or per number of clinical staff. [24, 26, 34, 38–40] Such "quantitative assessments of activity"[41] fit the definition of workload adopted by the

American Society of Health-System Pharmacists: "all activities related to providing pharmacy patient care services."[42] In contrast, measures of workload that describe the worker's subjective experience of work demands, [4, 32, 33, 38, 43, 44] are less commonly used and less systematically applied.[27, 30] This fact is unfortunate, because human factors specialists and other occupational researchers have made major advances in the theory and application of subjective workload measurement.[45, 46] Some human factors researchers claim that (1) expanding the scope of workload measurement and conceptualization is necessary from a whole-systems design standpoint, and (2) one specific expansion should be to view workload as a description of the subjective (mental) demands of a particular task.[23, 47, 48] That means, for instance, going beyond the quantification of medications dispensed, in order to understand the nature of the dispensing task and the *mental workload* experienced during such a task. Mental workload is a well researched construct that initially captured the interest of psychologists and organizational researchers in the 1980's[49, 50] and

[a]According to the International Ergonomics Association, human factors, also known as ergonomics, is the "scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance." Human factors specialists have been studying medication safety at least since 1960 and in the past decade have become increasingly involved in medication and patient safety efforts.

has since become a "viable and valuable" construct,[51] particularly in the human factors discipline.[45] Subjective assessments of task demands are considered valid and reliable measures of mental workload[52] and have been successfully used alongside other mental workload measures in health care, originally in anesthesiology,[53–55] and more recently in nursing,[47, 48] emergency medicine,[56, 57] and telemedicine,[58] as well.

Accordingly, the aims of the present study were to (1) assess pharmacy workload in terms of the subjective mental workload/demands of the dispensing task, and (2) investigate the effect of pharmacy workload, as such, on perceived medication safety and employee well being.

METHOD

Design

The study was a cross-sectional, paper survey administered to inpatient pharmacists and pharmacy technicians at two large US pediatric teaching hospitals, Hospital 1 and Hospital 2. The survey was part of a larger longitudinal study of patient and employee safety, which additionally included surveys of nurses and 150 hours of observation of medication management processes in central and satellite pediatric pharmacies in both hospitals. All parts of this study were approved by Institutional Review Boards at the University of Wisconsin-Madison and at each of the two hospitals.

Models Tested and Hypotheses

Task-related mental workload can be thought of as the balance of (a) demands inherent to the task itself ("task load"), and (b) the resources available to handle the task ("capacity").[47, 48, 55, 59] Most commonly, however, measures are taken of only the task demands.[59, 60] Task demands in a hospital pharmacy may have multiple sources; this study focused on two types: external mental task demands (interruptions, divided attention, and feeling rushed during dispensing tasks), and internal mental task demands (effort and concentration during dispensing tasks). Figure 1 depicts the predicted effects of both types of demands. To the extent that mental work is required for safe dispensing performance, greater demands should be associated with higher likelihood of errors and adverse drug events. Accordingly, it was hypothesized that workers' self-reported perceptions would reflect a corresponding relationship between workload and safety outcomes. However, a prior survey study in nursing, 48 with a similar research question, revealed that internal and external mental demands had quite different effects: the external demands—i.e., interruptions, divided attention, and feeling rushed—were positively associated with perceived medication error likelihood and burnout; internal demands—i.e., effort and concentration— were not associated with any outcomes. There was even evidence that increased levels of internal demands might be beneficial, a finding consistent with the notion that some level of effort and concentration is needed to stay aroused and to perform well.[61, 62] Indeed, some pharmacy research reports (or suggests) the possible benefits of internal mental demands.[3, 63, 64]

Based on the above, this study hypothesized the following:

- Hypothesis 1a: External mental task demands will be positively associated with the perceived likelihood of an error occurring during the medication dispensing process.
- Hypothesis 1b: Internal task demands will **not** be associated with perceived medication error likelihood.

- Hypothesis 2a: External task demands will be positively associated with the perceived likelihood of an adverse drug event occurring.
- Hypothesis 2b: Internal task demands will **not** be associated with perceived adverse drug event likelihood

Further, the study investigated the effects of workload, as defined above, on employee outcomes, hypothesizing the following:

- Hypothesis 3a: External task demands will be positively associated with job dissatisfaction
- Hypothesis 3b: Internal task demands will **not** be associated with job dissatisfaction
- Hypothesis 4a: External task demands will be positively associated with burnout
- Hypothesis 4b: Internal task demands will **not** be associated with burnout

We also tested differences between pharmacists and technicians, although we did not expect differences to emerge to the extent that the proposed workload-outcome relationship applies generally to cognitive work.

- Hypothesis 5: Workload-outcome relationships will **not** differ between pharmacists and pharmacy technicians

Participants

48 pharmacists and 31 pharmacy technicians participated. Respondent characteristics are reported in Table 1.

Procedures

Potential participants were informed of the study during information sessions and were hand-delivered survey packets. The surveys were completed on participants' own time. The survey was developed, implemented, and processed in conjunction with the University of Wisconsin Survey Center, and underwent rigorous pre-testing, including expert review and cognitive interviewing.[65] Frequent prompts in the survey asked participants to rate workload, error likelihood, and other constructs for *"the past 30 days."* All responses were on a numbered seven-point scale ranging from 0 to 6, with the response category labels "not at all," "a little," "some," "a moderate amount," "pretty much," "quite a lot," and "a great deal," as well as an option to mark "don't know."

Perceived mental demands of the task were measured by 5 items, developed based on the NASA Task Load Index (NASA-TLX)59 and the Subjective Workload Assessment Technique (SWAT),60 the two most psychometrically valid and reliable measures of subjective mental workload.52 Three of the 5 questions assessed the intensity of external demands: interruptions, divided attention between multiple tasks, and being rushed (e.g., "To what extent are there interruptions during the overall medication dispensing process?"). Two items assessed the intensity of internal demands: concentration and mental effort (e.g., "To what extent does the medication dispensing process require concentration?").

Medication error likelihood was assessed with a single item: "In actual practice, how likely is an error to occur through the medication dispensing process?" Adverse drug event likelihood was assessed with a single item: "In actual practice, how likely is it that a medication-related adverse event to a patient could occur in your hospital?" Job dissatisfaction was measured using a 3-item scale[66] that included one general dissatisfaction item ("In general, to what extent do you not like your job?") and 2 job satisfaction items (e.g., "In general, to what extent do you like working here?") that were reverse-scored for

the analysis. The 4-item emotional exhaustion subscale of Maslach and Jackson's burnout inventory [67] was used to assess burnout, containing items such as "To what extent do you feel emotionally drained from your work?"

Analyses

For univariate analyses, Pearson correlation coefficients for continuous variables and bivariate logistic regression coefficients (presented as odds ratios) for categorical variables were computed. Multivariate analyses consisted of four separate regression equations, one for each outcome variable. Binary logistic regression was used for dichotomized outcome variables and multiple linear regression for continuous outcome variables, carried out using SPSS 14.0 (Chicago: SPSS Inc.). In this study we chose to use four separate equations, rather than modeling all outcome variables at once by constructing a single structural model with maximum likelihood estimation, as we did in the prior study in nursing.[48] This decision was based on the considerable inflation of Type II error associated with applying a structural model to a small ($N < 100$) sample size. Because we hypothesized several null effects, we chose the analysis that most reduced Type II error. For the four regression models, covariates were entered to control for: hospital, job role (pharmacist vs. technician), number of hours worked per week, experience (total time with current employer), gender, and age. Only statistical values adjusted for the above covariates are reported below. An a priori alpha criterion of .05 was used and 95% confidence intervals are reported, where applicable. We also tested whether job role moderated the workload-outcome relationship by entering job role by workload interaction variables as predictors in the regression equations.

RESULTS

Of the 112 staff who received a survey, 83 returned a completed survey, for a total response rate of 74.1% (see Table 1 for more detail on response rates). For the present analyses, one case was removed because no job category was reported, and three cases were removed because those respondents reported working fewer than twelve hours per week. The final analyzed sample of 79 had 48 pharmacists and 31 technicians (see Table 1). Self-reported medication error and adverse drug event likelihood were each assessed with a single item and the distributions for both variables were right-skewed. Because of the non-normal distribution, these two variables were dichotomized. Following the dichotomization rule used in the previous nursing workload study,[48] error likelihood responses of "not at all" (n = 0), "a little" (n = 14) and "some" (n = 28) were considered "Low error likelihood." Responses of "a moderate amount" (n = 19), "pretty much" (n = 7), "quite a lot" (n = 7), and "a great deal" (n = 2) were considered "Moderate-or-higher error likelihood." Similarly, adverse drug event likelihood responses of "not at all" (n = 1), "a little" (n = 3) and "some" (n = 23) were considered "Low adverse event likelihood." Responses of "a moderate amount" (n = 23), "pretty much" (n = 9), "quite a lot" (n = 8), and "a great deal" (n = 11) were considered "Moderate-or-higher adverse event likelihood."

Univariate Results

Table 2 shows Pearson correlations for continuous variables and odds ratios for dichotomized variables. A few trends are worth noting. First, external mental task demands were positively associated with three of the four outcomes of interest. In contrast, there were no statistically significant positive associations between internal demands and outcomes of interest. In fact, there was a significant negative relationship between perceived internal task demands and job dissatisfaction. That is, workers reporting greater concentration and effort during dispensing were *less* dissatisfied with their jobs. Finally, with one exception, the outcome measures were positively associated with one another.

Multivariate Results

Univariate data are informative but insufficient when multiple types of workload are proposed to exist.[48] Therefore, we carried out multivariate logistic and linear regression analyses, in order to examine the effects of external task demands, adjusting for the effect of internal demands, and vice versa. We also included demographic variables in each statistical model and, using a step-wise approach, we added interaction variables in order to test whether one's job position (pharmacist vs. pharmacy technician) moderated the workload-outcome relationship.

Medication error likelihood—The overall model of perceived medication error likelihood regressed on a linear combination of (internal and external) mental task demands, and controlling for demographic variables, was significant (omnibus model $\chi^2 = 22.89$, df = 8, $p \leq .05$, Cox & Snell $R^2 = .26$). In support of Hypothesis 1a, external mental task demands were significantly associated with perceived error likelihood (*OR* = 3.61, 95% CI [1.81, 7.2]). In support of Hypothesis 1b, internal mental task demands were *not* positively and associated with perceived error likelihood (*OR* =.86, 95% CI [.47, 1.57]). The pattern of results did not change when medication error likelihood was analyzed as a continuous variable.

Adverse drug event likelihood—The overall model of perceived adverse drug event likelihood regressed on a linear combination of mental task demands, and controlling for demographic variables, was not significant (omnibus model $\chi^2 = 14.19$, df = 8, n.s., Cox & Snell $R^2 = .17$), suggesting that workload might not have a direct effect on perceived likelihood of adverse drug events, or that the effect was too small to detect.[b] When adverse drug event likelihood was analyzed as a continuous variable, the same pattern of results emerged (i.e., the omnibus model was not significant and there was a statistically significant effect of external mental task demands but not of internal task demands).

Job dissatisfaction—The overall model of job dissatisfaction regressed on a linear combination of mental task demands, and controlling for demographic variables, was significant ($F(8,69) = 2.74$, $p \leq .05$, adjusted $R^2 = .15$). As hypothesized, external mental task demands were significantly associated with self-reported job dissatisfaction ($\beta = .31$, 95% CI [.09, .52]). As hypothesized, internal mental task demands were *not* positively associated with self-reported job dissatisfaction; instead, similar to the univariate findings, there was a significant negative relationship such that as internal demands (concentration and effort) increased, self-reported job dissatisfaction decreased ($\beta = -.27$, 95% CI [−.48, −.05]).

Burnout—The overall model of burnout regressed on a linear combination of mental task demands, and controlling for demographic variables, was significant ($F(8,69) = 3.15$, $p \leq .05$, adjusted $R^2 = .18$). As hypothesized, external mental task demands were significantly associated with self-reported burnout ($\beta = .41$, 95% CI [.20, .62]). As hypothesized, internal mental task demands were *not* positively associated with self-reported burnout ($\beta = -.06$, 95% CI [−.27, .16]).

Demographic variables and professional differences—Demographic variables by themselves did not account for variations in outcomes. Focusing specifically on professional differences, however, there was only one case in which pharmacists differed from pharmacy

[b]Although a non-significant omnibus test does not typically justify further hypothesis testing, we report statistical parameter estimates for descriptive purposes. The odds ratio for external task demands was 1.62 (95% CI [.95, 2.77]), and for internal tasks demands it was 1.00 (95% CI [.59, 1.71]).

technicians: pharmacists were about five times more likely to have a higher estimate of adverse drug event likelihood than technicians (*OR* = 4.79, 95% CI [1.29, 17.79]). Consistent with Hypothesis 5, the interaction terms of internal workload-by-profession and external workload-by-profession were not significant.

DISCUSSION

Findings from a study of two pediatric hospitals support the notion that pharmacy workload is associated with perceived medication safety and employee well-being outcomes. In this case, however, workload was not measured using the typical prescription volume-based approach. Instead, workload was conceptualized and measured as the mental demands of pharmacy dispensing tasks. Mental demand levels, both internal and external, were very high in a sample of pharmacists and pharmacy technicians in two pediatric hospitals, a finding that is possibly cause for concern. This is because mental demands in this study were associated with important outcomes, namely, perceived medication error likelihood, job dissatisfaction, and burnout (and to a lesser extent, perceived adverse drug events).

As predicted, *external* task demands (interruptions, divided attention, rushing) were associated with those outcomes but *internal* task demands (concentration, mental effort) were not. Figure 2 graphically illustrates this finding, comparing external task demands (left-side panels) and internal task demands (right-side panels) for two outcomes, perceived medication errors and burnout. Figure 2 also compares pharmacy workers from the present study to nursing workers from the previous nursing study using the same measures to assess medication administration workload.[48] Results are quite similar between nursing and pharmacy, and the present study did not identify intra-pharmacy professional differences in workload-outcome relationships, suggesting that the effect of task-level mental workload may be a general phenomenon. It is also possible that there are truly differences between pharmacy professions and that this study did not have sufficient statistical power to detect those differences; if so, further research with larger sample sizes will be necessary to explore possible professional differences. Further work will also be required to test whether the findings generalize beyond the two hospitals in this study. This would require research in other hospitals, non-hospitals settings such as community pharmacies, and focusing on tasks besides dispensing such as consultations.

Not only were internal task demands not positively associated with outcomes but with greater intensity of internal demands individuals reported being less dissatisfied with their job. That suggests that not all dispensing task demands are unwanted. Indeed, workload research shows that work underload can result in both job stress[61] and poorer performance,[62] and there is some evidence of this in at least one previous pharmacy study.[3, 23] On the basis of such findings, Grasha[63] has pointed out that mindfulness, which requires internal mental demands such as concentration and effort, can improve pharmacists' performance:

> Taking more time to become mindful or to consciously focus on work in process or completed benefits patient safety. This entails increasing the time spent as a reflective practitioner and using processes that actively facilitate such thinking. A general sensitivity to the interplay between cognitive and other psychosocial factors and pharmacy practices should be a part of such analyses.[63]

Similarly, based on findings of high levels of pharmacist job satisfaction despite self-reported work overload,[4] Mott hypothesized that "some pharmacists may enjoy the 'pressures of the day' and look forward to solving the myriad issues associated with the complex world of pharmacy practice."[64] Most writing on pharmacy workload, however, assumes that increasing levels of work demands will have unwanted effects, perhaps because of the tendency toward objective conceptualizations of workload. The assumption

that more is worse, independent of type of workload, may wrongly support initiatives to simplify tasks such as dispensing. Pharmacy automation, including automated dispensing systems/robots for cart fill and bar coding technologies, may reduce demands for concentration and effort, and may not address the real task-related problems, those of interruptions, divided attention, and rushing. Some studies show that medication dispensing automation increases[68] or does not affect[69] workload as traditionally measured. It remains to be seen how automation affects the nature and intensity of mental task demands and, consequently, pharmacy workers' cognitive performance.

This study joins several others that show both high levels of subjective work demands in pharmacy and an effect of some of those demands on medication safety and quality of work life outcomes. Some of those studies show that pharmacists perceive workload to contribute to unwanted outcomes [8, 38, 43, 70] while others, as in this study, have tested the relationship between separate measures of workload and outcomes.[27, 33, 43] We know of only one series of studies, however, that generally explored the effects of mental demands, task-specific demands, or a combination of the two,[3, 23, 31, 63, 71, 72] and none in hospital pharmacies. There are, however, several studies focused on specific examples of mental demands. For example, the seminal study of Flynn and colleagues[6] in an ambulatory care pharmacy showed a relationship between interruptions and dispensing errors. Interruptions, divided attention, and rushing, the three facets of external mental demands in this study, have all been variously shown or suggested to have an effect on pharmacists.[6, 8, 24, 72–74]

A focus on task-specific mental workload as opposed to a focus on prescription volume or rate is important for a number of reasons. First, as one study noted, "workload volume cannot be manipulated or controlled."[75] Concentrating on controlling mental task demands rather than volume may be a more feasible solution, especially given seemingly uncontrollable national trends of increasing volumes and decreasing staffing. Second, just as staffing ratios, the dominant measure of workload in nursing, may not represent actual nursing demands,[76] prescription volume or rate may be a poor measure of pharmacy demands. For example, volume may not reflect the difficulty of the work: a hospital technician filling 200 oral liquid doses per unit of time may be less burdened than one distributing 100 doses to twenty patient medication drawers in each of five units in the same time span; pharmacists verifying the same number of prepared medications will experience different levels of mental workload depending on the complexity of the preparations. A pharmacist may transcribe 40 prescriptions, but that does not say much about how many times he or she was interrupted by a question, was concurrently engaged in a demanding phone conversation, or felt rushed because of the urgency of the drug orders. Indeed, in a simulation study, experimenter manipulations of the prescription filling rate were not associated with changes in perceived task-level workload,[31] and a more recent study reported that subjective workload ratings, not "actual workload," were related to pharmacists' turnover intentions.[43] This may be why volume-based measures of pharmacy workload is not always predictive of medication safety, such as in one study of five hospital pharmacies that found no relation between volume-based workload and errors in compounding IV mixtures.35 Third, by studying the subjective workload experiences of workers, researchers, designers, policy makers, managers, and others can better understand what part those individuals play in managing workload. The pharmacy worker is a cognitive agent who can deploy cognitive strategies, problem-solving behaviors, and other resources at his or her disposal in order to deal with demands, even ones that initially appear overwhelming.23, 77 (It is worth pointing out that "overload" does not refer to a fixed amount of work; rather, subjective overload "occurs when individuals believe they do not have the skills or capacities to satisfactorily perform job tasks."61) For all of the above reasons, it may be important to supplement objective measures of workload that rely on

counting work units (not only rate and volume, but also work hours78 and staffing36, 79) with subjective measures that assess the nature and perceived intensity of work.

Limitations

As is common in task workload measurement,[59, 60] our study assessed task demands, or "task load," not specifically accounting for individuals' perceived capacity to handle those demands. Leedal and Smith[55] describe the limitation of measuring only the demands aspect of workload: "Although objective and replicable for study purposes, task demands do not necessarily equate with workload because of varying skills and experience among those performing the task." To some extent, subjective reports of demands provide implicit information about worker capacity. For instance, an individual better able to handle time pressure might report not rushing as much as a less able individual. Nevertheless, a next step for task-related mental workload research in pharmacy is to more deliberately measure workers' capacity or resources for dealing with mental demands. These could include staffing resources, technology, training, experience, cognitive traits, and cognitive strategies.

It is both a strength and a limitation of this study that subjective measures were used to assess study constructs. It is a strength because of the insight into a person's cognitive load that comes from subjective assessment: "there is no other way to measure such concepts as workload … directly unless we ask the participant"[80] Additionally, the safety science literature suggests that safety-related behavior is often driven by safety perceptions (e.g., perceived error likelihood).[81, 82] Nevertheless, physiological, cognitive task analytic, and other methods are available to measure workload, and observation, chart review, and simulation studies can be carried out to measure medication safety outcomes. Those methods should be used, perhaps in conjunction with self-reporting, to make a stronger case. Similarly, job dissatisfaction and burnout self-report measures can be supplemented by measuring actual turnover and symptoms resulting from psychosocial stress.

Further work should also expand beyond the task-level workload measures used here in order to assess the effects of physical and emotional task-level workload as well as that of job-level and unit-level workload. Other safety- and work attitude-altering aspects of the work environment besides workload will need to be included as well.[38] Similarly, outcome variables can be added to address the impact of workload on cognitive processes (e.g., communication, memory, decision making) safety-relevant behavior (e.g., procedural violations, error reporting), and individual outcomes (e.g., physiologic strain). Certainly, adding variables and testing a larger set of workload-outcome and outcome-outcome associations will require far larger sample sizes than those obtained in the present study.

Both perceived error likelihood and perceived adverse event likelihood were measured using single items. A related concern is that the unreliability of single-item measures places an upper limit on their validity.83 On its face, the validity of both measures is reasonable due to simple question wording; "error" and "medication-related adverse event" are terms widely known and used in hospital pharmacy. Expert review by a team of survey research experts, engineers, physicians, nurses, and a pharmacist and 16 cognitive interviews were employed to ensure that the questions were relevant and that researchers and clinicians interpreted the questions similarly (for more detail, see elsewhere84). The question about adverse events was not specific to only so-called "preventable adverse drug events"9—that is, those caused by errors—and included adverse events unrelated to workers' cognitive overload, such as chance or unknown patient allergies. Although many—perhaps most85—adverse drug events are caused by errors, implicating a possible workload-related mechanism, the broad scope of adverse events in this study may have attenuated the workload-adverse event relationship. A common test of measurement item (internal) validity is the degree to which the measure covaries with a theoretically related measure, known as concurrent validity.86

Indeed, in this study both single-item outcome variables were correlated with measures of external task demands and with each other (Table 2). For example, the odds ratio of 6.3 between the single-item measure of error likelihood and the single-item measure of adverse event likelihood can be taken as evidence of concurrent validity[87], especially because it is easily interpretable given the theoretical basis elaborated above. [88] The evidence of concurrent validity is weakest for the adverse drug event measure, suggesting the need to improve that measure and perhaps to supplement it with estimates of adverse event likelihood based on observations, chart reviews, or incident reports.

This study was conducted in a pediatric setting, whose unique properties, briefly mentioned above, may have affected the reported levels of workload and outcomes. The participants in this study may have differed from pharmacists and technicians in other (e.g., smaller) pediatric hospitals, in non-pediatric acute care settings, or in non-hospital pharmacy practices. External validity—and thus, generalizability—is threatened when context-specific factors, including ones mentioned above, influenced the dependent variable. By including demographic factors (e.g., work experience, age) in the regression models, some of the context-specific effects were controlled, assuming limited restriction of range. Other context-specific factors, such as work setting or worker specialty, did not vary and hence could not be controlled for (nor their effects estimated). It is therefore possible that being a pediatric pharmacy worker in the study hospitals at the time of this study influenced the workload-outcome relationships. The probability of such moderating effects is diminished considering parallel findings between pharmacy and nursing workers (Figure 2) as well as similar findings of the safety and health effects of task demands across numerous industries, organizations, and worker types. Therefore, we contend that the effects of task demands are general workplace phenomena that would be replicated in other health care contexts, although the specific context might play some role.

A final limitation of the study is its inability to establish causality, something that might be addressed through laboratory research and possibly by using structural modeling on a large-sample data set to arbitrate between competing models of causality. Those approaches can also allow a better test of the actual mechanisms at play that mediate the relationship between workload and outcomes.

CONCLUSION

Despite those limitations, the findings of this study are important. Beyond simply confirming the hypothesis that workload covaries with important outcomes, this study establishes the value of using subjective assessments of workload. It reveals the importance of measuring task-level mental workload in pharmacy, and the complexity of dispensing work, wherein mental demands have both positive and negative effects.

Importantly, those who advocate for regulation of work volume without consideration of the mental demands of the work itself[26] may be mobilizing a costly solutions that may not get at the real problem. The same can be said for technological interventions that reduce concentration and effort but not interruptions, divided attention, or time pressure, or so-called “clumsy automation”[89] that takes over simple work and leaves workers with more demanding work.[90]

To end on a hopeful note, however, we must stress that there are actually many solutions for workload through design interventions, policy-making, and management, and the goal should not be to enumerate them, but rather to fit the proper solution to the workload challenge. Of course, understanding the nature of the workload challenge must be a priority.

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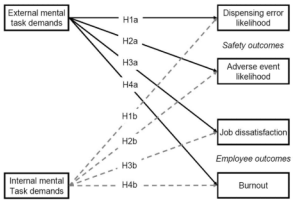

Figure 1.
Graphical depiction of hypothesized positive effects (solid lines) and lack of such effects (dashed lines) between workload and outcome measures.

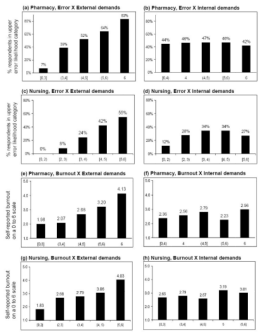

Figure 2.
Effect of external (left side) and internal (right side) mental demands on medication error likelihood (top two rows) and burnout (bottom two rows). Findings in pharmacy from this study (rows 1 and 3) are nearly identical to findings in a previous study in pediatric nursing units[48] (rows 2 and 4).

Table 1

Sample response rate and demographics

	Pharmacists		Pharmacy Technicians	
	Hosp 1	**Hosp 2**	**Hosp 1**	**Hosp 2**
Response rate (%)	33 (76.7)	17 (89.5)	20 (70.0)	12 (57.1)
Final N after removed cases (see text)	31	17	19	12
Gender, % female	35.5%	64.7%	73.7%	75.0%
Race, % white, not Hispanic	96.8%	88.2%	89.5%	83.3%
Education, % completing at least college degree	96.8%	94.1%	31.6%	25.0%
Age (%)				
18–29	3.2%	17.6%	26.3%	16.7%
30–39	6.5%	41.2%	21.1%	41.7%
40–49	41.9%	35.3%	47.4%	16.7%
50+	48.4%	5.9%	5.3%	25.0%
Shift, % day shift	54.8%	58.8%	47.4%	50.0%
Hours/week, Mean (SD)	37.3 (10.4)	45.4 (14.4)	31.4 (10.4)	40.3 (3.9)
Years in job, Mean (SD)	14.1 (8.1)	6.0 (7.2)	7.2 (7.0)	5.7 (7.0)
Years in unit, Mean (SD)	14.8 (8.1)	5.2 (6.7)	7.2 (6.9)	5.0 (6.9)
Years with employer, Mean (SD)	15.9 (7.6)	9.5 (8.7)	7.5 (6.8)	7.3 (11.5)
Years in occupation, Mean (SD)	23.4 (7.1)	11.8 (9.3)	10.1 (8.4)	10.7 (8.7)

Table 2

Descriptive statistics and correlations between study variables

	Descriptive statistics		Correlations (Pearson correlation coefficients [r], and odds ratios [OR])				
	Mean (SD)	**Cronbach's alpha**	**External task demands**	**Internal task demands**	**Medication error likelihood**	**Adverse drug event likelihood**	**Job dissatisfaction**
External demands	4.30 (1.14)	0.85					
Internal demands	4.74 (0.94)	0.77	r = 0.19				
Medication error likelihood (OR)	2.62 [b] (1.29)	--	OR = 2.56[a]	OR = 1.04			
Adverse drug event (OR)	3.33 [b] (1.51)	--	OR = 1.58[a]	OR = 1.11	OR = 6.30[a]		
Job dissatisfaction	1.57 (1.16)	0.88	r = 0.21	r = −0.26[a]	OR = 1.59[a]	OR = 1.26	
Burnout	2.63 (1.50)	0.90	r = 0.39[a]	r =.03	OR = 1.60[a]	OR = 1.52[a]	r = 0.60[a]

[a] $P \leq .05$

[b] Means are reported here, but these variables were dichotomized for the purpose of all analyses (see text)