The effect of deep relax inspiration–pursed lip breathing on nurse fatigue in the emergency department

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Abstract. Reducing nurse fatigue is essential for providing quality and safe services. The deep relax inspiration–pursed lip breathing (DRI–PLB) technique enables increased oxygenation, resulting in a relaxation effect that ultimately lowers the fatigue level. This study determined the effect of DRI–PLB on nurse fatigue levels in this study. This was a pre–post intervention study involving 39 emergency nurses studied for 6 consecutive days. The fatigue level was subjectively measured using the work fatigue measurement questionnaire (KAUPK2) and the visual analogue fatigue scale (VAFS) and objectively measured based on light and sound reaction times. The intervention included performing 10 min of DRI–PLB in the middle of a work shift. Based on KAUPK2, a significant decrease in the fatigue rate (from 71.8% moderate–severe fatigue pre-intervention to 46.2% fatigue post-intervention, p < 0.001) was noted. Daily pre- and post-intervention measurements of VAFS and reaction time for 6 days revealed significant improvements in the VAFS score and reaction times, with p < 0.001. The pattern of the work shift was not correlated with the fatigue level. DRI–PLB alleviates work fatigue. Thus, this technique can be used as an option for reducing fatigue in a busy work setting.

1. Introduction
The emergency room (ER) of a hospital becomes the forefront that has a vital role and has a special aspect because it is risking someone’s life. The performance of medical services in ER tends to reflect on the overall quality of hospital services.

Fatigue is one of the main problems faced by physicians and nurses in ER. Work fatigue experienced by nurses can lead to various problems that can ultimately affect patient safety. Hence, the issue of nurse fatigue and patient safety is becoming an international issue. Patients may be unsafe if their health worker is in a fatigued condition. Syahrendra examined 110 nurses and midwives in a hospital in Jakarta using KAUPK2 (a work fatigue measurement questionnaire) and recorded ‘a little tired’ and ‘tired’ responses by 49.1% and 50.1% of the respondents, respectively [1].
Studies have established that pursed lip breathing (PLB) decreases the respiratory rate, oxygen consumption, respiratory activity and shortness of breath. In addition, this technique increases the tidal volume and exercise tolerance [2]. Relaxation breathing exercises, such as deep relax inspiration (DRI), can increase oxygen levels in the body. The combination of DRI and PLB (DRI–PLB) is a breathing relaxation technique that not only lowers CO₂ levels and increases O₂ levels in the body but also has a relaxing effect and reduces work fatigue. This method has become the best approach for alleviating work fatigue in individuals, such as ER nurses, who have a hectic schedule. Therefore, the DRI–PLB technique was employed in this research for reducing work fatigue of the subjects.

In this research, subjective examination of work fatigue was performed using KAUPK2 and visual analogue fatigue scale (VAFS) questionnaires. KAUPK2 comprises 17 questions related to fatigue complaints. On the other hand, VAFS uses a scale of 0–10 to gauge the acute fatigue experienced by a person. The subjects were asked to encircle the number that seemed most appropriate for their present fatigue level. Both the questionnaires are already tested for their validity and reliability [3].

Thus far, no objective or subjective study has been conducted in Indonesia to explore relaxing effects of breathing exercises, such as DRI–PLB, on work fatigue.

2. Methods
This study utilised an experimental design (pre- and post-intervention) for assessing the effect of DRI–PLB, a relaxation breathing intervention exercise, on fatigue of nurses in ER of Persahabatan Hospital, Jakarta. Data were collected from May 27, 2016, to June 6, 2016. This research has passed the test of ethical study from Persahabatan Hospital (No. 108/KEPK-RSUPP/05/2016) and the ethical review from the Health Research Ethics Committee, Faculty of Medicine, Universitas Indonesia - Cipto Mangunkusumo Hospital (No. 511/UN2.F1/ETIK/2016).

The exclusion criteria were ER nurses who were on leave during the research, those who were unwilling to participate in the study, pregnant nurses and those with heart or lung ailments. Dependent variables were work fatigue based on KAUPK2, reaction time and VAFS score, whereas independent variables were age, sex, nutritional status (based on BMI), number of family members, work shift (regular/elongated/random), hours of sleep per day, time taken to commute, presence of a baby at home and mode of transport.

A total of 42 nurses fulfilling the study inclusion criteria were taken from the pre-intervention, intervention and post-intervention data set. Measurement data on work fatigue were subjectively obtained through KAUPK2 and VAFS questionnaires and objectively through measurement of light and sound reaction time using the Lakassidaya tool. Intervention was conducted by practising the DRI–PLB relaxation technique for 10 min. Measurement on each subject was performed for 6 days following his/her work schedule. Data retrieval was performed in the middle of the work shift, at approximately 4 h after the subject commenced duty. Number of subjects who remained in the study until its completion was 39.

3. Results
Primary data used in this research were collected through interview and direct measurements using KAUPK2, VAFS and reaction time. Secondary data were indirectly obtained from reference books and journals containing theories relevant to the subject under study.

Characteristics of the study subjects who met the inclusion criteria are listed in Tables 1 and 2.

Table 1. Characteristics of the study subjects (ER nurses) at Persahabatan Hospital Jakarta.

| Characteristics     | n = 39 | %   |
|---------------------|--------|-----|
| Sex                 |        |     |
| Female              | 22     | 56.4%|
| Male                | 17     | 43.6%|
| Marital status      |        |     |
| Married             | 32     | 82.1%|
| Not married         | 7      | 17.9%|
Table 1. Continue

| Characteristics                  | n  = 39 | %   |
|----------------------------------|--------|-----|
| Babies at home                   |        |     |
| Yes                              | 9      | 23.1%|
| No                               | 30     | 76.9%|
| Number of people live in the     |        |     |
| same house                       |        |     |
| Alone                            | 3      | 7.7% |
| 1 person                         | 6      | 15.4%|
| More than 1 person               | 30     | 76.9%|
| Transportation to the workplace  |        |     |
| On foot                          | 5      | 12.8%|
| Car                              | 1      | 2.6% |
| Motorcycle                       | 19     | 48.7%|
| Public transportation            | 14     | 35.9%|
| Shift pattern                    |        |     |
| Regular                          | 7      | 17.9%|
| Elongated                        | 21     | 53.9%|
| Random                           | 11     | 28.2%|
| BMI category                     |        |     |
| Underweight                      | 2      | 5.3% |
| Normoweight                      | 17     | 44.7%|
| Overweight                       | 8      | 21.1%|
| Obesity                          | 11     | 28.9%|

The age range of the study subjects was 23–55 years, and their working period in the ER ranged from 1 to 30 (average, 5) years.

Table 2. Subjects’ characteristics of age, working period, work travel time and amount of sleep time.

| Characteristics                  | Mean            |
|----------------------------------|-----------------|
| Age                              | 33.34 ± 6.98    |
| Working period in ER RSP (year)  | 5 (1–30)        |
| Work travel time to RSP (min)    | 45 (5–150)      |
| Amount of sleep in a day         | 6.97 ± 1.37     |

3.1. Characteristics of study subjects based on pre-intervention KAUPK2

Characteristics of the study subjects based on pre-intervention KAUPK2 were employed to examine their fatigue level prior to intervention with DRI–PLB respiratory relaxation exercises. The results of all study subjects (39 ER nurses of Persahabatan Hospital Jakarta) experiencing fatigue are presented in Table 3.

Table 3. KAUPK2 pre-intervention on study subjects’ characteristics.

| Characteristics | Mild fatigue | Moderate-to-severe fatigue | Total (n = 39) | P    | OR    | 95% CI       |
|-----------------|--------------|----------------------------|----------------|------|-------|-------------|
| Sex             |              |                            |                |      |       |             |
| Male            | 3 (17.6%)    | 14 (82.4%)                 | 17             | 0.288| 2.67  | 0.58–12.19  |
| Female          | 8 (36.4%)    | 14 (63.8%)                 | 22             |      |       |             |
| Age             |              |                            |                |      |       |             |
| <40 years       | 7 (20%)      | 28 (80%)                   | 35             | 1.00 | 0.2   | 0.1–0.39    |
| ≥40 years       | 4 (100%)     | 0 (0%)                     | 4              |      |       |             |
Table 3. Continue

| Characteristics                  | Mild fatigue | Moderate-to-severe fatigue | Total (n = 39) | P     | OR    | 95% CI     |
|----------------------------------|--------------|---------------------------|----------------|-------|-------|------------|
| Marital status                   |              |                           |                |       |       |            |
| Married                          | 8 (25.0%)    | 24 (75.0%)                | 32             | 0.379 | 0.44  | 0.08–2.42 |
| Not married                      | 3 (42.9%)    | 4 (57.1%)                 | 7              |       |       |            |
| Babies at home                   |              |                           |                |       |       |            |
| Yes                              | 1 (11.1%)    | 8 (88.9%)                 | 9              | 0.399 | 0.25  | 0.03–2.29 |
| No                               | 10 (33.3%)   | 20 (66.7%)                | 30             |       |       |            |
| Number of people living at the same house |              |                           |                |       |       |            |
| 1–2 person                       | 3 (33.3%)    | 6 (66.6%)                 | 9              | 0.693 | 1.38  | 0.28–6.84 |
| ≥2 person                        | 8 (25.7%)    | 22 (73.3%)                | 30             |       |       |            |
| Transportation                   |              |                           |                |       |       |            |
| On foot                          | 2 (40.0%)    | 3 (60%)                   | 5              | 0.609 | 1.85  | 0.27–12.95|
| Vehicles                         | 9 (26.5%)    | 25 (73.5%)                | 34             |       |       |            |
| Shift Pattern                    |              |                           |                |       |       |            |
| Regular                          | 4 (57.1%)    | 3 (42.9%)                 | 7              | 0.083 | 4.76  | 0.86–26.48|
| Irregular                        | 7 (21.9%)    | 25 (78.1%)                | 32             |       |       |            |
| Nutritional Status (IMT)         |              |                           |                |       |       |            |
| Normal                           | 5 (29.4%)    | 12 (70.6%)                | 17             | 1.0   | 1.11  | 0.27–4.52 |
| Malnutrition                     | 6 (27.3%)    | 16 (72.7%)                | 22             |       |       |            |
| Working period                   |              |                           |                |       |       |            |
| <11 years                        | 7 (21.2%)    | 26 (78.8%)                | 33             | 0.04  | 0.13  | 0.02–0.89 |
| ≥11 years                        | 4 (66.7%)    | 2 (33.3%)                 | 6              |       |       |            |
| Work travel time                 |              |                           |                |       |       |            |
| ≤30 min                          | 5 (31.3%)    | 11 (68.8%)                | 16             | 0.734 | 1.29  | 0.31–5.27 |
| >30 min                          | 6 (26.1%)    | 17 (73.9%)                | 23             |       |       |            |
| Sleep time                       |              |                           |                |       |       |            |
| ≥6 h                             | 10 (28.6%)   | 25 (71.4%)                | 35             | 1.0   | 1.20  | 0.11–12.95|
| <6 h                             | 1 (25%)      | 3 (75.0%)                 | 4              |       |       |            |

3.2. Comparison of the pre- and post-interventional work fatigue based on KAUPK2 and VAFS during the 6 days of examination

Table 4 depicts the significant effect of DRI–PLB respiratory exercise on work fatigue, as measured subjectively using KAUPK2 and VAFS. A significant difference was noted between subjective fatigue (KAUPK2) levels pre- and post-intervention (p < 0.001).

Table 4. Subjective fatigue levels (KAUPK2) pre- and post-intervention.

| KAUPK2           | Mild fatigue | Moderate-to-severe fatigue | p Value |
|------------------|--------------|----------------------------|---------|
|                  | Score 17–45  | Score 46–102               |         |
| Pre Intervention | 11           | 28                         |         |
|                  | 28.2%        | 71.8%                      |         |
| Post-Intervention| 53.8%        | 46.2%                      | <0.001* |

*Mc Nemar test
The measurement of work fatigue using VAFS was conducted pre- and post-intervention (10 min of breathing relaxation exercise); a significant decrease in the fatigue level was observed. The complete set of comparative results is presented in Figure 1. Statistical analysis using paired t-test yielded an overall p value of <0.001 from days 1 to 6. Therefore, it can be concluded that the average difference between the pre- and post-interventional work fatigue was statistically significant (p < 0.05).

![Graph of fatigue based on the visual analogue fatigue scale (VAFS) score for all 39 subjects.](image)

Table 5 describes the frequency of the subject’s responses after performing the DRI–PLB breathing relaxation exercise for 6 days. It can be inferred that most of the subjects felt benefits of DRI–PLB intervention in assuaging perceived fatigue.

| Day | Reduced | Same | Increased | Total |
|-----|---------|------|-----------|-------|
| I   | 33      | 6    | 0         | 39    |
|     | 84.6%   | 15.4%| 0%        | 100%  |
| II  | 37      | 2    | 0         | 39    |
|     | 94.9%   | 5.1% | 0%        | 100%  |
| III | 37      | 2    | 0         | 39    |
|     | 94.9%   | 5.1% | 0%        | 100%  |
| IV  | 36      | 3    | 0         | 39    |
|     | 92.3%   | 7.7% | 0%        | 100%  |
| V   | 35      | 4    | 0         | 39    |
|     | 89.7%   | 10.3%| 0%        | 100%  |
| VI  | 37      | 2    | 0         | 39    |
|     | 94.9%   | 5.1% | 0%        | 100%  |

3.3. Comparison of the work fatigue assessment based on the reaction time
For comparing work fatigue based on the reaction time, measurements of light reaction time (LRC) and sound reaction time (SRC) were performed. In this investigation, the reaction times pre- and post-intervention were compared. Graphs for LRC and SRC are provided in Figures 2 and 3, respectively.
From statistic testing using paired \( t \)-test and the obtained \( p \) value of <0.05 from days 1 to 6, it can be concluded that the average daily difference in LRC between pre- and post-intervention was statistically significant. However, when see the definition of fatigue based on the reaction time, only the average LRC of the 1st day that included in the fatigue criteria (>240 ms).

| Day I | Day II | Day III | Day IV | Day V | Day VI |
|-------|--------|---------|--------|-------|--------|
| Pre   | Post   | Pre     | Post   | Pre   | Post   |
| Mean  | 246.94 | 196.37  | 199.03 | 176.90| 203.78 | 175.61 |
| SD    | 60.99  | 37.84   | 33.30  | 29.91 | 47.52  | 38.56  |
| Difference | 50.56 | 22.13   | 28.17  | 23.51 | 21.61  | 22.20  |

Paired \( t \)-test

**Figure 2.** Graph of light reaction time pre- and post-intervention (n = 39).

| Day I | Day II | Day III | Day IV | Day V | Day VI |
|-------|--------|---------|--------|-------|--------|
| Pre   | Post   | Pre     | Post   | Pre   | Post   |
| Mean  | 248.12 | 189.54  | 198.67 | 168.57| 196.95 | 165.87 |
| SD    | 61.23  | 45.22   | 38.60  | 26.25 | 51.64  | 40.88  |
| Difference | 58.58 | 30.09   | 31.08  | 27.63 | 42.01  | 30.95  |

Paired \( t \)-test

**Figure 3.** Graph of sound reaction time pre- and post-intervention (n = 39).

### 3.4. A comparison of fatigue assessment based on the work shift pattern

The ER nurse work shift did not comply with the pattern of 2 days each morning, afternoon and night shifts followed by 2 days off. This irregularity is attributed to several nurses continuing their education, having children aged <1 year or exchanging shifts with colleagues because of personal needs.

Therefore, research data was grouped into three categories: (1) regular, according to the actual pattern (2 days morning, 2 days afternoon, 2 days night and 2 days off); (2) elongated, a shift that is patterned normally, but the number of days in each shift does not amount to exactly 2, for example, 3 days of
morning shift, 1 day of afternoon shift, 2 days of night shift and 2 days off and (3) irregular (random), the shift does not adhere to the actual pattern in any way.

Shift patterns did not indicate any consistent change in the daily fatigue level. During assessment of work fatigue based on SRC, random shifts exhibited the greatest change, whereas, during assessment based on LRC, the regular shift resulted in maximum change.

4. Discussion
In this study, work fatigue was measured in two ways: subjectively through KAUPK2 and VAFS and objectively through measurements of SRC and LRC using the Lakassidaya tool. Measurements on the subjects were performed for 6 days of their work schedule. Data retrieval was executed in the middle of the work shift, at approximately 4 h after the subjects work commenced. Pre- and post-intervention data were collected; the intervention was a relaxation breathing technique of DRI-PLB for 10 min.

According to pathophysiology of fatigue, age and nutritional status that associated with the cell degeneration process can lead to a workload that exceeds the body’s capacity and results in fatigue [4]. In this study, 72.7% subjects with malnutrition suffered from moderate-to-severe fatigue, whereas only 70.6% of those with normal BMI experienced a similar fatigue level. Therefore, it can be postulated that respondents who are malnourished have a greater tendency to experience moderate-to-severe fatigue than those with a normal nutritional status. Results of Russeng’s study on bus drivers also identified a substantial relationship between BMI and fatigue.

In the literature, it has been stated that older subjects captured the stimulus as rapidly as younger subjects, but responded in a slower manner [4,5]. The results of this study documented that in subjects aged 20–29 years, 81.8% experienced moderate-to-severe fatigue. Comparatively, in subjects aged 30–39 years, 79.2% had a similar feeling of fatigue, whereas those aged ≥40 years did not undergo severe fatigue. This observation is incompatible with the theory that age can affect the physical strength of workers [4]. With increasing age, physical stamina may decrease, although it may be influenced by other factors, such as physical exercise and mental maturity. This result is probably observed due to several reasons, including the small number of research subjects aged >40 years, that is, only 4 out of 39 subjects (10.2%). Moreover, younger subjects had babies who demanded their attention. Owing to their long tenure in the organisation, subjects aged ≥40 years could adapt well to workplace conditions and activities.

The contribution of mental burden and responsibilities that can pathophysiologically lead to fatigue [6] is evident from this study. Married subjects faced 75% moderate-to-severe fatigue, those with a baby at home suffered from 88.9% fatigue and those who lived with ≥2 people experienced only 73.3% fatigue.

Results asserted the significant effect of DRI-PLB on the feeling of work fatigue, as measured by KAUPK2 and VAFS. With KAUPK2, the number of study subjects who experienced moderate-to-severe fatigue was 71.8% pre-intervention, whereas, this value drastically decreased to 46.2% post-intervention. From the obtained p value of <0.001, it can be inferred that there is a significant difference between subjective fatigue levels pre- and post-intervention.

From the data analysis, it can be deduced that there is a considerable decrease in the KAUPK2 and VAFS scores; it can be interpreted that the subject experiences lesser fatigue after performing respiratory relaxation exercises. Based on the comparison of work fatigue using KAUPK2 (Table 5), it can be perceived that exercises can significantly decrease the feeling of work fatigue in a subject (p < 0.05).

This observation is consistent with physiological effects of breathing relaxation exercises that are capable of increasing the oxygenation and lowering CO₂ levels, thereby decreasing the build-up of lactic acid and resulting in decreased fatigue. In addition, breathing exercises also have a relaxation effect that can lower the need for O₂ and inhibition effects of the central nervous system, thereby decreasing the fatigue level. This result is also in accordance with the bucket model of fatigue that is used as a guide by the Department of Labour, Ministry of Business, New Zealand. According to this theory, relaxation is one way of overcoming work fatigue [4].
Based on the correlation of subject characteristics with a change in the feeling of (subjective examination with KAUPK2 and VAFS) pre- (day 1) and post-interventional (day 6) fatigue, there was a significant relationship between the age of the ER nurse and decreasing feeling of work fatigue. A significant correlation was also observed between the nutritional status (category of BMI) and a declining work fatigue level based on VAFS.

This investigation also assessed subjects’ fatigue every day whenever they finished undergoing the DRI–PLB intervention by inquiring about their feeling of fatigue. The questions had three different answer choices, namely, reduced, similar or increased fatigue after exercise.

Comparison results showed that post-interventional SRC was shorter than pre-intervention SRC, and the difference was statistically significant (p < 0.05). However, when viewed from the definition of fatigue based on reaction time, only the average of SRC on first day that included in criteria of fatigue (>240 ms). In the present study SRC was faster than LRC. This variation is probably due to study subjects experiencing more visual fatigue. In addition, each job has a different fatigue level, and the characteristics also vary.

A study on effects of subject characteristics on changes in fatigue pre- and post-intervention (objective examination of fatigue using LRC and SRC) confirmed a significant relation between means of transportation to the workplace and decreased work fatigue level [6]. Furthermore, a significant correlation between the nutritional status (BMI) and decreasing work fatigue level was recorded using LRC.

According to the theory, transport to the workplace is included in the non-work related factors that can affect fatigue [6]. In this study, the subjects’ mode of transport to the workplace showed a significant relationship with fatigue when objective examination using the Lakassidaya tool for measuring light and sound reaction times was performed.

No prior study has explored the association between breathing relaxation exercises and work fatigue. Only literature discussing effects of PLB in patients with chronic obstructive pulmonary disease and asthma exists [7].

This study has a few limitations. At the time of data collection, subjects must have worked for 4 h. However, because of their busy schedule, data could not be collected precisely after 4 h. Anticipating such circumstances, data retrieval was conducted immediately after the subject completed the service task and before he/she rested. In addition, endurance level screening of the subject involving a 6-min road test with simple fitness measures was not performed. Nevertheless, subjects were fit for work and performed the routine duties of ER nurses. Another factor is that the work shift was not entirely according to the rules; hence, the work shift analysis was classified into the three patterns of regular, elongated and irregular (random).

5. Conclusion
Based on the description and result analysis, it can be concluded that the DRI–PLB breathing relaxation exercises have substantial effects in lowering fatigue of ER nurses in Persahabatan Hospital Jakarta. Significant differences were noted in the work fatigue experienced by nurses pre- and post-intervention based on KAUPK2 and VAFS. According to LRC and SRC, work fatigue levels decreased after DRI–PLB breathing relaxation exercises. In this study, the shift pattern did not affect the work fatigue level.

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