

BREATHING APPARATUS AND VENTILATION

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INTRODUCTION

Some individuals who are required to perform physical exercise while wearing self-contained breathing apparatus (SCBA or SCUBA) sometimes experience respiratory distress and/or panic behavior. This behavior is often associated with morbidity and mortality, and it is not uncommon to find that a breathing apparatus is functional and air remains in the tank at follow-up. It has been recognized for many years that factors of a psychogenic nature can influence resting as well as exercise metabolism. Most of the experimental literature dealing with this topic has involved the hypnotic manipulation of metabolism, and it has been found that heart rate, cardiac output, forearm blood flow, respiration rate, ventilatory minute volume and oxygen consumption can be influenced systematically with hypnotic alterations in perception (1). Furthermore, independent of hypnotic perturbation of effort sense, it has also been shown that selected psychological states and traits influence ventilation and behavior in exercising subjects wearing breathing apparatus (2,3). This research will be summarized in the present address, and recommendations for screening and training paradigms will be suggested.

SCBA RESEARCH

Despite the fact that major advances have taken place in the design of respirators, it is still widely recognized that "psychological" problems continue to exist. Unfortunately, very little research has been directed toward an understanding of the "person" component of the respirator-person interface; that is, research has focused on respirator variables with little attention paid to person variables. While it has been proposed that certain "types" of individuals be eliminated from work tasks requiring the wearing of SCBA, there has not been a concise diagnostic statement presented to enable such a screening approach to be adopted (2). The purpose of our first experiment was to address this problem.

The purpose of the investigation (3) was to evaluate the effectiveness of trait anxiety in predicting respiratory distress resulting from heavy physical work performed while wearing an industrial respirator. Spielberger's trait anxiety scale was administered to 45 male volunteers in order to identify individuals with elevated trait anxiety. This testing was followed by a pulmonary function test, resting 12-lead electrocardiogram (ECG), and an exercise ECG. Individuals with cardiovascular and/or pulmonary impairment did not continue with subsequent tests. The subjects next completed three treadmill tasks varying in intensity from 35% to 80% of $\dot{V}O_2$ max, and each trial lasted for 10 minutes. Twenty-five of these individuals performed the exercise tasks while wearing a self-contained breathing apparatus (SCBA) in the demand mode, whereas the remaining 20 subjects used a pressure-demand SCBA. The reason for terminating exercise was classified as respiratory or non-respiratory on the basis of self-report responses on a 7-point dyspnea scale, as well as general responses concerning muscular fatigue and respiration. It was predicted, based upon trait anxiety scores, that six individuals would have respiratory distress, and five (83%) of these predictions were correct. It was also predicted that 39 of the 45 subjects would not experience distress and 38 (97%) of these predictions were correct. These results (3) have since been replicated in a second experiment. It is concluded that objective measures of trait anxiety can be used to identify those individuals who are most likely to experience distress while wearing an industrial respirator and performing heavy physical exercise.

SCUBA RESEARCH

Approximately 40% of the fatalities associated with SCUBA diving each year are classified as "unexplained" or due to "undetermined" causes. There is both a theoretical rationale and empirical evidence supporting the view that a substantial number of these "unexplained" cases are associated with factors of a psychological nature, and our survey of 300 experienced divers revealed that 54% had experienced panic or near-panic behavior on one or more occasions (4,5). While some authorities maintain that individuals who experience panic behavior while scuba diving will discontinue this activity, it is now apparent that panic behavior can occur in experienced, as well as novice scuba divers. Our subsequent laboratory research has indicated that:

1. It was possible to predict (double-blind) panic behavior in beginning SCUBA divers with 88% accuracy using a measure of trait anxiety.
2. Experienced scuba divers differing in levels of trait anxiety tend to have similar responses on selected perceptual and metabolic variables studied during an underwater SCUBA simulation. The exception to this generalization was the observation that respiration rate was significantly lower in high trait anxious divers.
3. Elevated trait anxiety in male test subjects was associated with respiratory distress during arm ergometer exercise on land, but this relationship was not observed in female test subjects.
4. Females judged a paced surface swim at 90% of maximum velocity to be less effortful than did male swimmers despite a higher exercise heart rate in the females.
5. Anxiety responses during and following underwater swimming was associated with the interaction between water temperature and protective apparel

CONCLUSION

It is concluded that high trait anxious individuals are at risk when wearing SCBA or SCUBA and performing vigorous physical activity. It is recommended that efforts should be made to identify these individuals a priori with an aim toward (a) screening them out, or (b) evaluating efforts to develop selected stress minimization strategies.

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