



ORIGINAL ARTICLE

Scuba diving in children: Physiology, risks and recommendations[☆]



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Review

Abstract

Introduction: The increase in recreational scuba diving in recent years, including children, involves risks and the possibility of accidents. While legislation, conditions and risks of scuba diving are well documented in adults, scientific evidence in scuba diving by children and adolescents is sparse and isolated. Furthermore, existing guidelines and recommendations for adults cannot be transferred directly to children.

Methods: These circumstances have led to the Group on Techniques of the Spanish Society of Paediatric Pulmonology (SENP) to perform a literature search to review and update the knowledge about scuba diving in children.

Results: Physiological adaptations of the body are examined during the dive, as well as the anatomical and physiological characteristics of children that should be taken into account in scuba diving. The most common types of accidents and its causes, as well as the risks of scuba diving practice in children with previous diseases are discussed, along with details of the medical and psychological requirements for scuba diving to be considered in the assessment of child and adolescent.

Conclusions: A list of recommendations for scuba diving with compressed air in children is presented by a group of experts.

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PALABRAS CLAVE

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Buceo recomendaciones;
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Revisión

Buceo en la edad pediátrica: fisiología, riesgos y recomendaciones**Resumen**

Introducción: El gran auge de la práctica recreativa del buceo en los últimos años, incluyendo a los niños, comporta riesgos y la posibilidad de accidentes. Mientras que las normativas, los requisitos y los riesgos del buceo en adultos están bien fundamentados, la evidencia científica en niños y adolescentes es escasa. Asimismo, las guías y recomendaciones existentes dirigidas a los adultos no pueden ser aplicadas directamente a los niños.

Métodos: Estas circunstancias han motivado al Grupo de Técnicas de la Sociedad española de Neumología Pediátrica (SENP) a realizar una búsqueda bibliográfica para revisar y actualizar los conocimientos sobre el buceo en la edad pediátrica.

Resultados: Se examinan las adaptaciones fisiológicas del organismo durante la inmersión, así como las características anatómicas y fisiológicas propias de los niños que deben considerarse con relación al submarinismo; se exponen las causas y tipos más frecuentes de accidentes, así como los riesgos de su práctica en niños con distintas patologías; y se detallan los requisitos médicos y psicológicos para el buceo que deben respetarse en la evaluación de niño y adolescentes.

Conclusiones: Finalmente, se formulan unas recomendaciones de expertos para la práctica del buceo con aire comprimido en la edad pediátrica.

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Introduction

The number of children engaging in scuba diving has steadily increased in recent years, and now represents between 5 and 10%^{1,2} of recreational divers. The majority are between the ages of 12 and 17 years, but 1.5% of active divers are children under the age of 12 years.^{3,4} Despite this, Spanish regulations on children's diving are difficult to interpret and vary substantially between local jurisdictions.⁵ Likewise, although the medical risks of diving in adults are well-founded, scientific evidence available regarding children is scarce^{6,7} and recommendations are aimed at adults; there are none for the paediatric population.^{8,9}

Considering this, the Group on Techniques of the Spanish Society of Paediatric Pulmonology decided to review the literature with the aim of establishing recommendations for scuba diving in children. In this article, we tackle the inherent issues regarding the practice of underwater activities for children, placing an emphasis on diving with compressed-air tanks. Taking into consideration anatomophysiological, psychological and ergonomic aspects, data on children's diving is reviewed and updated, the most common types of accidents are presented, and the medical and psychological aspects to be considered when evaluating a child/adolescent who wishes to dive are discussed. Lastly, a few experts' recommendations on scuba diving for children are summarised, in the absence of established facts on the subject.

Physiological changes associated with diving

When diving, the body must adapt to an environment with more pressure during immersion (compression) and then

Table 1 Physiological and anatomical factors to be considered in children engaging in underwater activities.

- Pulmonary development until the age of eight
- Higher pulmonary closing volume
- Reduced pulmonary compliance (higher risk of barotrauma)
- Higher number of respiratory infections and ORL
- Functional immaturity of the Eustachian tube opening mechanism
- Unfavourable body surface:weight ratio (risk of hypothermia)
- Incomplete bone development
- Limited ability to understand mathematical and physical laws
- Emotional instability
- Limited ability for self-care and the care of others

reestablish during ascent (decompression) and reach surface pressure conditions.¹⁰ An adequate knowledge of these adaptations and of the anatomophysiological characteristics of children (Table 1) will minimise the risks of diving.

Respiratory system

When diving, pressure increases by 1 atmosphere for each 10m of descent.¹¹ High pressure levels are relatively harmless and well tolerated by the body as long as they can be balanced or compensated. The increase in pressure during descent will compress the gas in the body's air cavities (lungs, middle ear, nasal sinus) and this gas will re-expand during ascent. In compressed-air diving, the main strategy

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