

Review Article

Sudden infant death syndrome

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ABSTRACT

The sudden death of infants younger than one year is known as SIDS. It is a major cause of mortality among infants less than one year of age. There is little focus in the literature on sudden infant death syndrome (SIDS). Thus, this review aims to provide new insights on the incidence, risk factors and prevention of SIDS in infants. Following preferred reporting items for systematic review and meta-analysis (PRISMA) guidelines, this review explored eligible articles from PubMed, Google Scholar, and research gate databases. Several keywords were used for the search to obtain all possible related articles. The inclusion criteria were reviews and original articles focused on the current subject and written in English. The eligible articles used to compile this review were published between 2007 and 2021. Three main titles were discussed in this review: incidence, risk factors, and prevention. SIDS is the most common reason for death among infants aged less than one year. There is great variation in the global incidence of SIDS. Factors related to the sleeping environment are the major risk factors for SIDS and should be the focus. Hence, following the recommendations of the American academy of pediatrics can reduce incidence of SIDS.

Keywords: SIDS, Risk factors, Incidence, Prevention

INTRODUCTION

Sudden infant death syndrome (SIDS) is defined as the death of an infant less than one year of age with the onset of a lethal episode that apparently occurs during sleep.^{1,2} This syndrome was first defined in 1969, and the definition has been refined by consensus through international conferences.³

Unexplained deaths, even after autopsy, clinical history, thorough investigation, and examination of the death scene, are classified as SIDS.^{3,4} The exact mechanism of SIDS is not well known; however, the triple-risk hypothesis states that SIDS occurs with the overlapping of three factors: an infant with inherent vulnerability who is within a critical developmental period and is exposed to a stressful sleep environment. Infants who die due to SIDS tend to have abnormalities in respiratory and cardiac control within the brainstem. It is thought that the

combination of these abnormalities and environmental stresses, such as sleep positioning, exposure to tobacco, and temperature, leads to a terminal cascade of hypoxia, bradycardia, apnea, and death.^{5,6}

Cases have been grouped into a classification system that categorizes them based on the presence of atypical and typical features, and completeness of death investigation.⁷

SIDS is responsible for 35-55% of deaths among infants between one month and one year of age.⁸ SIDS is the leading cause of unexpected death among infants in Western nations and is responsible for almost half of all post-neonatal deaths, despite following risk reduction campaigns.^{2,9} The lowest rates of SIDS were recorded in Japan and the Netherlands, where the rates were 0.09% and 0.1 per 100 live births, respectively.^{10,11} On the other hand, higher rates were reported in the USA with 0.57/1000 live births and in the UK with 0.41/1000 live births.^{12,13} There

is a gap in the literature regarding SIDS; therefore, we conducted this review regarding several aspects, including incidence, risk factors, and prevention.

LITERATURE SEARCH

Following preferred reporting items for systematic review and meta-analysis (PRISMA) guidelines. Obtaining articles to develop this review required systematic online research through scientific websites, including PubMed, Research Gate, and Google Scholar. We searched for scientific articles related to our topic of interest using aforementioned scientific websites, using various keywords, including SIDS, sudden death, syndrome, infants, incidence, prevention, and risk factors. The keywords were used in various combinations to obtain all possible articles related to SIDS.

The articles obtained from this search process were reviewed according to their titles to exclude any articles that did not focus on our subject. Then, the abstracts of the articles were reviewed, and articles not written in English, letters to the editor, and duplicate articles were excluded, whereas original articles, systematic reviews, and review articles were included. The articles reviewed to write this review were published between 2007 and 2021.

STATUS OF KNOWLEDGE

Incidence and burden of SIDS

SIDS is the most common cause of mortality among infants aged between one month and one year.¹⁴ Deaths during sleep are not likely to be due to SIDS.⁷ However, it has been stated that deaths might occur during nap, sleep, or night sleep.¹⁵ Almost 10% of SIDS victims experience an apparent life-threatening event some weeks or days before their death, and surviving infants have an increased risk of dying of SIDS by 5-10%.¹⁵

SIDS is more commonly observed among males than females; this suggests that this higher prevalence among males may be due to genetic factors involved in SIDS.^{4,16,17} Most deaths due to SIDS occur in the first six months of life with a peak incidence occurring between the second and fourth months of life.^{14,15}

There is great variation in the global incidence of SIDS.¹ The incidence of SIDS was estimated to be between 1–3/1000 live births in most developed countries in the early 1990s.¹⁵ In their study, Taylor et al reported that the lowest sudden infant death rate was found in the Netherlands, with 0.19 cases out of 1000 live births.¹⁸ There is a potential variation in the incidence of SIDS among different ethnicities. The risk is doubled among Native Americans, black infants, and Alaska Natives compared with non-Hispanic white infants.³

Since the 2000s, the incidence of SIDS in the US has decreased by 53%.⁶ Since then, the rate of SIDS has been

stable, whereas the overall mortality rates of infants in the US have declined slightly. Evidence of this decline is the increasing recognition of deaths due to strangulation or asphyxiation in sleep.⁶ A study in 2002 showed that the incidence of SIDS in the US was the highest among Alaskan Native, African Indian, and African American populations, whereas the lowest incidence was found in Asian and Central or South American populations.^{19,20}

Almost 4,500 deaths are recognized annually as sudden unexpected infant deaths in the US.²¹ However, this number includes deaths due to SIDS, asphyxiation during sleep, or deaths reported with insufficient information.³ SIDS is responsible for almost 2,500 deaths of this total number.¹⁴ In the UK, the incidence rate of SIDS was reported to be 0.27/1000 live births, and in Italy, it was about 1/1000 live births.²² A systematic review found that the prevalence of SIDS suggested high rates in Africa, ranging from 3.7/1000 live births in South Africa to 2.5/1000 live births in Niger and 0.2/1000 live births in Zimbabwe.²³

After the implementation of public health campaigns that encouraged families to place infants on their backs for sleep, most countries that implemented these campaigns reported reduced rates of SIDS by 50-90%.⁹ Data from 13 predominantly developed countries showed that the majority of countries had a major reduction in SIDS rates from 1990 to 2005, with the largest reduction occurring before 2000.¹⁵ The incidence of SIDS reduced from 1.2 cases/1000 live births in 1992 to 0.5 cases/1000 live births in 2006.¹ It has been stated that current incidence of SIDS is less than one case/1000 live births and remains low.²⁴ However, infants still die due to SIDS, which constitutes the largest reason for postnatal infant mortality and accounts for approximately 30% of postnatal deaths for infants between 28 days and 1 year of age.¹⁵ In addition, risk of SIDS among preterm infants is still elevated.¹

The true incidence of SIDS may be masked by a so-called diagnostic shift or the use of diagnoses other than SIDS on death certificates, such as positional accidental asphyxia, accidental suffocation, and indeterminate causes. The diagnostic shift may partially explain the fact that postnatal death rates for both non-SIDS and SIDS have remained static since 2000.¹⁵

Risk factors of SIDS

The most recent evidence has suggested that the pathogenesis of SIDS is multi-factorial.¹⁴ The risk factors of SIDS were categorized and included socioeconomic factors, race and geographical risk factors, season and climate risk factors, perinatal risk factors, maternal and antenatal risk factors, and sleeping environments.¹⁵

Socioeconomic class

Lower socioeconomic status is a predictor of SIDS; socioeconomic status is measured by the income,

education, or occupation of the parents. The rate of SIDS deaths among poor families has increased from 47% to 74%.¹⁵

Race and geographic risk factors

Black parents are less likely to use supine positions for infants' sleeping and are more predisposed to use non-standard sleep locations. One study found that 79% of black infants who died of SIDS were in a sleeping position other than a crib, and 67% shared a bed with someone else.²⁵ Black and native Americans in the US have a two-to seven-fold increased risk of SIDS compared to Māoris in New Zealand and aboriginal Australians, respectively. The influence of genetics and the cultural practices of childcare can also be responsible for the differences in racial risk ratios.²⁵

Seasonal and climate risk factors

Months of cold weather could have an impact on the rates of SIDS through multiple associated risk factors, such as infectious organisms, infant care practices, the temperature in the room of the infant, and metabolic and nutritional processes.¹⁵

Perinatal risk factors

Prematurity of infants is a risk factor for SIDS. Infants born prematurely have a relative risk for SIDS of four to six times; the relative risk increases with a decrease in gestational age. The incidence of SIDS in premature infants of less than 1500 gm is estimated to be 8.7/1000 live births.¹⁵

Maternal and antenatal risk factors

Maternal substance abuse and mental illness are strongly associated with SIDS. Infants born to mothers diagnosed with alcohol use disorders during pregnancy have a seven-fold increased risk of SIDS, and it was estimated that maternal alcohol use is directly responsible for 16.4% of all SIDS deaths.²⁶ Illness in either parent, and especially in both parents, is a strong predictor of SIDS; the risk is doubled when both parents have mental illness and are addicts.²⁷

Maternal smoking during pregnancy is a major risk factor for SIDS.⁹ Prenatal and postnatal tobacco exposure is associated with SIDS.²⁸ Prenatal smoke exposure leads to a reduction in lung volume and compliance, as well as reduced heart rate variability to stress.⁹ In addition, postnatal exposure has emerged as a separate risk factor. Nicotine has neuroteratogenic effects, leading to alterations in autonomic pathways, including decreased arousal to hypoxia.⁹ Autopsy studies have shown reduced nicotinic acetylcholine receptors in the brainstems of children exposed to tobacco and died of SIDS compared to those who were not exposed.²⁹

Sleeping environment

Factors related to the sleeping environment are the most important risk factors for SIDS; these factors involve sleeping position, covering, and bed sharing.^{3,15} The sleeping position is a strong risk factor for SIDS; the prone and side sleeping positions are potentially more dangerous compared to the supine position.³⁰ Side and prone sleeping positions increase the risk of hypoxia, hypercapnia, and hyperthermia during sleeping; therefore, they double the risk of SIDS when compared with the supine position.³

Multiple layers of blankets or clothing on the infant and warmer room temperatures have been associated with an increased risk of SIDS.³¹⁻³³ The increased risk of overheating is particularly evident when infants are sleeping in the prone position, and heat loss from the face is reduced; this risk is less clear in the supine position.⁹

Bed-sharing is more common among poorer and less educated families and in the southern and western US.³⁴ Bed-sharing with parents is associated with an increased risk of SIDS and is especially dangerous for infants younger than four months.³⁵ The frequency of bed-sharing has remained unchanged in the US.³

Other factors related to the sleeping environment include pillows, soft bedding, soft objects, head- and face-covering during sleeping, and bumper pads.³⁶

Prevention of SIDS

The incidence of SIDS decreased from 1.2 cases/1000 live births to 0.5 cases/1000 live births in 1992 and 2006, respectively.¹ The incidence is currently less than one case for every 1000 live births and is still low.²⁴ This drop in SIDS incidence was due to increasing awareness of the syndrome and the change in the recommended position for infants sleeping from prone to supine.³⁷ This spread of awareness and knowledge led to a greater survival rate in infants between the ages of one month and one year.¹

The American academy of pediatrics (AAP) established guidelines for reducing the risk and prevention of SIDS.⁶ The protective factors can be summarized in main categories, including sleeping position, breastfeeding, pacifiers, firm bedding, and reduced covering.⁴⁰

Sleeping positions

The recommendation for the supine position applies to all infants up to one year of age or until the infant can roll from supine to prone and back again.³ Many parents use wraps and wearable blankets to reduce the risk of SIDS.³⁸ These products have rare adverse events and could provide a supine position for infants.³

The infant should sleep in a crib that has all parts correctly installed. The mattress should be firm and covered with a fitted sheet, with no gaps between the mattress and the side

of the crib. Soft pillows, toys, blankets, and bumper pads should be avoided.³ The AAP has recommended that the crib should ideally be placed next to the parents bed.⁶

Breastfeeding

Parents are encouraged to breastfeed their infants as much as possible and for as long as possible because breastfeeding for infants to any extent and for any duration is protective. Breastfeeding decreases SIDS among infants who are exclusively breastfed.³⁹

It has been shown that breastfeeding or giving expressed breast milk to infants is protective against SIDS.⁴⁰ In addition, breastfeeding was found to be a major protective factor for SIDS in a retrospective cohort study, where it represented 95.2% of the investigated protective factors.⁴¹ The protective effect of breastfeeding can be explained by its role in reducing the risk of intestinal infections.¹⁵

Pacifiers

The use of a pacifier at the onset of sleep is protective against SIDS, even when it falls out of the mouth after the infant falls asleep.³⁹ A pacifier is encouraged to be used in infants up to one year to prevent SIDS.¹⁵

Pacifiers have been reported to have a strong protective effect against SIDS.⁴² The proposed mechanism involves decreased high-frequency heart rate variability, increased low-frequency heart rate variability, increased sleeping blood pressure, increased arousability, and improved autonomic control.⁴³

Firm bedding and reducing covering

Reducing covering and firm bedding can be useful in preventing hyperthermia and reducing the risk of SIDS.¹⁵ Swaddling should not be used once the infant begins to attempt to roll over, as deaths may occur due to tooling into the prone position.⁴⁴

CONCLUSION

SIDS is the most common cause of death among infants under one year of age. There is great variation in the global incidence of SIDS. The true incidence of SIDS may be masked by the use of diagnoses other than SIDS on death certificates. There are many risk factors for SIDS; however, factors related to the sleeping environment are the major risk factors for SIDS and should be the focus. Following the recommendations of the AAP for the prevention of SIDS can reduce the incidence. However, further studies are still needed to investigate in depth the risk and protective factors of SIDS.

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REFERENCES

1. Imhof R, Imhof N, Wasnick R, Khan SA. Current concepts of sudden infant death syndrome: A review of literature. *Archivos de Med.* 2015;6(4):35.
2. Horne RS. Sudden infant death syndrome: current perspectives. *Internal Med J.* 2019;49(4):433-8.
3. Adams SM, Ward CE, Garcia KL. Sudden infant death syndrome. *Am Family Physician.* 201;91(11):778-83.
4. Van Nguyen JM, Abenhaim HA. Sudden infant death syndrome: review for the obstetric care provider. *Am J Perinatol.* 2013;30:703-14.
5. Goldwater PN. A perspective on SIDS pathogenesis. the hypotheses: plausibility and evidence. *BMC Med.* 2011;9:64.
6. Moon RY. Task Force on Sudden Infant Death Syndrome. SIDS and other sleep-related infant deaths: expansion of recommendations for a safe infant sleeping environment. *Pediatrics.* 2011;128(5):1030-9.
7. Krous HF, Beckwith JB, Byard RW, Rognum TO, Bajanowski T, Corey T et al. Sudden infant death syndrome and unclassified sudden infant deaths: a definitional and diagnostic approach. *Pediatrics.* 2004;114(1):234-8.
8. Bechtel K. Sudden unexpected infant death: differentiating natural from abusive causes in the emergency department. *Pediatr Emerg Care.* 2012;28:1085-9.
9. Moon RY, Horne RS, Hauck FR. Sudden infant death syndrome. *Lancet.* 2007;370(9598):1578-87.
10. Maternal and Child Health Statistics of Japan: Boshi Eisei Kenkyuu Kai. 2006.
11. Central Bureau of Statistics, Netherlands. 2006. Available at: <http://www.cbs.nl/en-GB>. Accessed on 25 January, 2023.
12. Hoyert DL, Mathews TJ, Menacker F, Strobino DM, Guyer B. Ann Summary Vital Statistics. *Pediatrics.* 2006;117:168-83.
13. Report: Unexplained Deaths in Infancy, 2005. *Health Stat Q.* 2006;82-6.
14. Moon RY, Fu L. Sudden infant death syndrome: an update. *Pediatr Rev.* 2012;33(7):314-20.
15. Franco P, Raoux A, Kugener B, Scaillet S, Groswasser J, Kato I et al. Sudden Infant Death Syndrome: From Epidemiology to Pathophysiology. *Encyclopedia of Sleep.* 2013:638-44.
16. Getahun D. Maternal and obstetric risk factors for sudden infant death syndrome in the United States. *Obstet Gynecol.* 2004;103:646-52.
17. Mage DT, Donner EM. Is excess male infant mortality from sudden infant death syndrome and other respiratory diseases X-linked? *Acta Paediatr.* 2014;103:188-93.
18. Taylor BJ. International comparison of sudden unexpected death in infancy rates using a newly proposed set of cause-of-death codes. *Arch Dis Child.* 2015;1.

19. Mathews TJ, Menacker F, MacDorman MF. Centers for Disease Control and Prevention, National Center for Health Statistics. Infant mortality statistics from the 2002 period: linked birth/infant death data set. *Natl Vital Stat Rep*. 2004;53:1-29.
20. Rienks J, Oliva G. Using social marketing to increase awareness of the African American infant mortality disparity. *Health Promot Pract*. 2013;14:408-14.
21. Centers for Disease Control and Prevention (CDC). CDC grand rounds: public health approaches to reducing U.S. infant mortality. *MMWR Morb Mortal Wkly Rep*. 2013;62(31):625-8.
22. Perrone S, Lembo C, Moretti S, Prezioso G, Buonocore G, Toscani G et al. Sudden infant death syndrome: beyond risk factors. *Life*. 2021;11(3):184.
23. Osei-Poku GK, Thomas S, Mwananyanda L, Lapidot R, Elliott PA, Macleod WB et al. A systematic review of the burden and risk factors of sudden infant death syndrome (SIDS) in Africa. *J Global Heal*. 2021;11.
24. Malloy MH. Prematurity and sudden infant death syndrome: United States 2005-2007. *J Perinatol*. 2013;33:470-75.
25. Fu LY, Moon RY, Hauck FR. Bed sharing among black infants and sudden infant death syndrome: interactions with other known risk factors. *Acad Pediatr*. 2010;10(6):376-82.
26. O'Leary CM, Jacoby PJ, Bartu A. Maternal alcohol use and sudden infant death syndrome and infant mortality excluding SIDS. *Pediatrics*. 2013;131(3):e770-8.
27. Webb RT, Wicks S, Dalman C. Influence of environmental factors in higher risk of sudden infant death syndrome linked with parental mental illness. *Arch Gen Psychiatr*. 2010;67(1):69-77.
28. Mitchell EA, Ford RP, Stewart AW. Smoking and the sudden infant death syndrome. *Pediatrics*. 1993;91(5):893-6.
29. Machaalani R, Say M, Waters KA. Effects of cigarette smoke exposure on nicotinic acetylcholine receptor subunits $\alpha 7$ and $\beta 2$ in the sudden infant death syndrome (SIDS) brainstem. *Toxicol Appl Pharmacol*. 2011;257(3):396-404.
30. Colvin JD, Collie-Akers V, Schunn C. Sleep environment risks for younger and older infants. *Pediatrics*. 2014;134(2):e406-12.
31. Ponsonby A-L, Dwyer T, Gibbons LE, Cochrane JA, Wang Y-G. Factors potentiating the risk of sudden infant death syndrome associated with the prone position. *N Engl J Med*. 1993;329:377-82.
32. Fleming P, Gilbert R, Azaz Y. Interaction between bedding and sleeping position in the sudden infant death syndrome: a population-based case-control study. *BMJ*. 1990;301:85-9.
33. Ponsonby A-L, Dwyer T, Gibbons LE, Cochrane JA, Jones ME, McCall MJ. Thermal environment and sudden infant death syndrome: case-control study. *BMJ*. 1992;304:277-82.
34. Colson ER, Willinger M, Rybin D. Trends and factors associated with infant bed sharing, 1993-2010: the National Infant Sleep Position Study. *JAMA Pediatr*. 2013;167(11):1032-7.
35. Vennemann MM, Hense HW, Bajanowski T. Bed sharing and the risk of sudden infant death syndrome: can we resolve the debate? *J Pediatr*. 2012;160(1):44-8.
36. Ruys JH, De Jonge GA, Brand R, Engelberts AC, Semmekrot A. Bed-sharing in the first four months of life: A risk factor for sudden infant death. *Acta Paediatr*. 2007;96:1399-403.
37. Mage DT, Donner M. A Unifying Theory for SIDS. *Int J Pediatr*. 2009;368270.
38. Hauck FR, Herman SM, Donovan M. Sleep environment and the risk of sudden infant death syndrome in an urban population: the Chicago Infant Mortality Study. *Pediatrics*. 2003;111(5 pt 2):1207-14.
39. Carlin RF, Moon RY. Risk factors, protective factors, and current recommendations to reduce sudden infant death syndrome: a review. *JAMA Pediatr*. 2017;171(2):175-80.
40. Hauck FR, Thompson JM, Tanabe KO, Moon RY, Vennemann MM. Breastfeeding and reduced risk of sudden infant death syndrome: a meta-analysis. *Pediatrics*. 2011;128(1):103-10.
41. Oliveira AM, Andrade PR, Pinheiro EM, Avelar AF, Costa P, Belela-Anacleto AS. Risk and protective factors for sudden infant death syndrome. *Revista Brasileira de Enfermagem*. 2020;73.
42. Alm B, Wennergren G, Mollborg P, Lagercrantz H. Breastfeeding and dummy use have a protective effect on sudden infant death syndrome. *Acta Paediatr*. 2016;105(1):31-8.
43. Yiallourou SR, Poole H, Prathivadi P, Odoi A, Wong FY, Horne RS. The effects of dummy/pacifier use on infant blood pressure and autonomic activity during sleep. *Sleep Med*. 2014;15(12):1508-16.
44. McDonnell E, Moon RY. Infant deaths and injuries associated with wearable blankets, swaddle wraps, and swaddling. *J Pediatr*. 2014;164(5):1152-6.

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