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Backpack improper use causes musculoskeletal injuries in adolescents: A systematic review

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Abstract:

BACKGROUND: This research is one of the very few studies, which seeks a focalized examination to observe the effects of the backpack on the teenager students. Adolescents prefer rucksacks as one of their favorite school bags during their school studies. This study inspects how knapsacks gradually bring changes as injuries in the bodies of school-going adolescents. There are ample studies in the past literature, which evidence the injuries of backpack among adolescents, such as backache, neck pain, and shoulder pain. The principal objective of this study is to determine the effects of backpacks on musculoskeletal injuries among school-going adolescents based on previous studies support in this research field.

MATERIALS AND METHODS: This review study selected observational studies from the past literature indexed in the databases of Scopus, PubMed, ScienceDirect, and CINAHL during 1999–2020. This review focused on the keywords of "Backpack," "Musculoskeletal Injuries," and "Adolescent" from MESH and selected 14 out of 210 articles based on the research objective. According to the Crombie Checklist, inclusion and exclusion criteria, and investigating the quality of the report, this review focused on literature evidence to the field under investigation.

RESULTS: Based on the chosen 14 articles, the findings of the present review indicated two outcomes by considering the impact of the backpack on musculoskeletal injuries and pains among adolescents. The results of the review studies specified that there was a statistically significant positive relationship between the prevalence of musculoskeletal injuries and pain using a backpack among most of the male and female adolescents. The findings also stipulate that injuries and pain intensity among female adolescents were higher than the male students.

CONCLUSION: The results of this review study specified that improper use of the backpack, which exceeded the standard weight, caused chorionic pain and injuries between both genders of adolescents. The generalizability of the results is suitable for this review study.

Keywords:

Adolescents, backpack, musculoskeletal injuries, pains

Introduction

In this modern world, the backpack is the most commonly used tool to carry supplies of daily work, and typically people, such as climbers, soldiers, school students, and university students, widely use different types of rucksacks for their various purposes.[1] In the recent times, backpacks are the most favorite bags among the adolescents of both genders,[2,3] and numerous studies have evidenced it in the past literature. Numerous researchers have identified different aspects of the backpack bags, which cause musculoskeletal injuries and pain in adolescents and teenagers, and it influences their life quality standard.[1,4] The heavy backpack makes trouble for the person, puts pressure on his/her back

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more than the usual, and bends their heads to pull forward their bodies to tolerate the overweight school bags. As a result, weighty backpacks put pressure on adolescents' neck's muscles and backbone, which leads to causing fatigue, injury, and, finally, anomalies of the spine.[5] The students use backpack from schooling to university education, and students keep using backpack after school, which becomes a habit in their day-to-day traveling routine. When adolescents' students make a habit of using a more massive backpack, it brings changes in their body structure and indicates some biomechanical, physiological, and different types of diseases.[6]

The past literature has identified that students use backpacks to carry their daily textbooks; they also use other tools and other equipment during the entire day.[7] Therefore, overweight carrying tools, habits, manners, and duration of carrying backpack are the factors that cause the change in the direction and curvature of the spine, musculoskeletal disorders, and pains such as backache and shoulder also direct effect of backpack carriage on lumbar lordosis of school adolescents is carried out by[4] The past studies evidenced the high prevalence of musculoskeletal injuries because of carrying heavy backpack and findings of the prior literature recommended that backpacks should contain a wide shoulder strap or a pad to provide comfort by distributing weight on students shoulders.[8] The backpack should contain a back pad to spread the weight to the entire body, which would protect students' bodies carefully.[9] The American Academy of Orthopedic Surgeons stated that the characteristics of a good backpack have two shoulders straps, back pads, waistband, low weight, and wheels.[10] At the stages of various age groups, the effects of cargo transportation vary. Any kind of stress on the spine manifests itself as pain, injury, and discomfort.[8] Numerous earlier studies have specified that carrying heavy school bags causes musculoskeletal disorders among adolescents' students.[11-15]

The findings of the past literature indicated that 40% of students complained about the pain on their shoulders and 88% had pain on their neck and back when carrying their backpacks going to schools.Besides, previous studies stipulated that 30%–80% of students reported that they faced pain and injuries by carrying school bags.[14] A previous study related to high school students specified that the most significant issues of musculoskeletal discomfort were identified in the shoulders, neck, and back among school-going students, and it revealed a significant relationship with carrying heavy backpacks.[16] In an earlier study, Zahiri-Sarvari reported the prevalence of back and shoulder over 10% of the students' body weight and research suggested to distribute the weight of the backpack on both shoulders.[6] Another study reported that 38% of students carry backpacks, which exceeded 20% of their body weight,[5] and in most of the reported cases, students using backpacks exceeding 7.50% of their body weights cause musculoskeletal injuries.[12] The findings of another study carried out in India reported that 7.60% of females had experienced skeletal, shoulder, and neck pain at least once during a school year.[9] A study recognized that almost 51% of students experienced musculoskeletal and foot pains during the year of school going.[10] The findings of a previous studies stipulated that individuals carrying backpacks experience effects on all anatomical parts of the body.[11-13]

The above arguments indicate that when backpacks are overweight than the specified approved standard, these rucksacks cause various health issues, such as pain in the backbone, musculoskeletal injuries, and upper body parts.[14] The findings from the previous researches specified that carrying these backpacks in the more extended period caused drooping shoulders and kyphosis problems among students.[15,16] Previously, numerous researchers have investigated the effects of heavy backpacks, and the findings identified the shortage of valid measuring tools to examine the relationship between pain and changes in the structure of the students' body.[17] The prospective demand and attitude of adolescents toward heavy backpacks arising issues, it is essential to redesign these backpacks. Therefore, the comfort of the bag is vital before designing and producing backpacks for students and other individuals. The first-line health-care teams should focus on the design and confirm of backpacks, and they should be bound to instruct the production teams by preventing the events of physical threatening and mental health issues. This study is among the few researchers, which initiated a survey to identify and offer useful variables with the systematic investigation of the musculoskeletal side effects and injuries in reaction to use heavy backpacks.

Materials and Methods

This review study selected observational studies and performed the comprehensive review and selected published articles from the past literature indexed in the databases of Scopus, PubMed, ScienceDirect, and CINAHL. This current review lasted from October 2019 to January 2020. This review focused on the keywords of "Backpack," "Musculoskeletal Injuries," and "Adolescent" from MESH and selected 14 out of 210 articles based on the research objective. According to the Crombie Checklist, inclusion and exclusion criteria, and investigating the quality of the report, this review focused on literature evidence to the field under investigation.

Inclusion criteria

This current review performed a comprehensive and systematic analysis, selected, and filtered the keywords whose scores were between a1 and b2 based on Lloyd–Smith's classification system. The titles of the review studies were available in the previously published articles in the scientific literature and indexed in the databases of Scopus, PubMed, Science Direct, and CINAHL.[18]

Data collection, analysis, and extraction

The authors of this review study performed a comprehensive and systematic review process on the published papers and selected relevant studies after filtration procedure using scores between a1 and b2 based on the classification system of Lloyd–Smith. This review study considered the articles focusing on the effects of the backpack and the causes of musculoskeletal injuries among adolescents' students. This review study comprised various phases, and the stage performed the search for previously published articles, titles, and abstracts. The second stage of the review study consisted of thorough checking of the full texts of the articles by the authors. The authors discussed the cases showing disagreement and included only those articles, which reached a complete and unconditional agreement by all the authors of this review study. Figure 1, the process of Inclusion and exclusion of studies Shows the initial to the final syntheses.

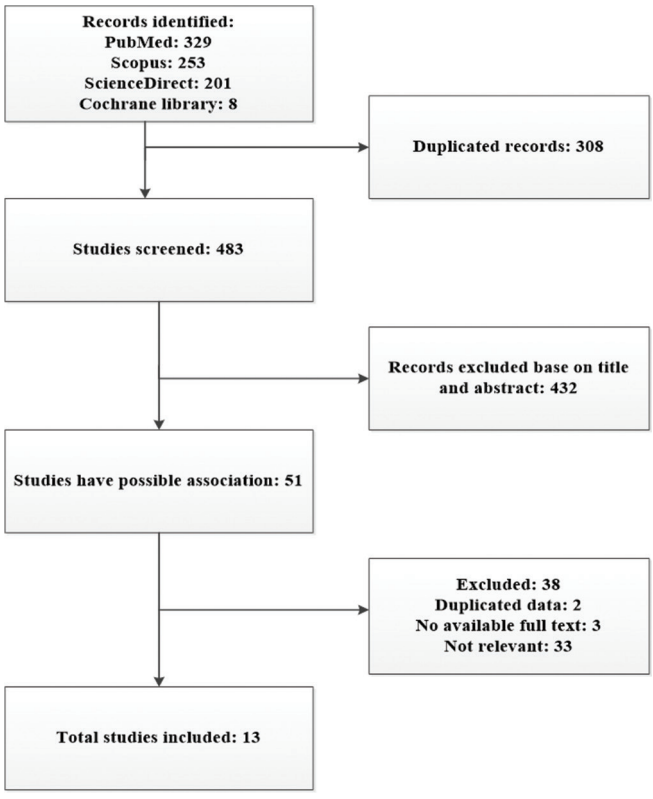

Figure 1: Flow of studies through the review

Quality measure

This current review incorporated the Crombie device to assess the quality of each selected article. The determined score ranged from 0 to 16, and it indicates the maximum score. The classification of the assessment demonstrated the quality of the selected articles with the score levels described as weak, (0–5), moderate (6–11), and good (12–16), respectively. If there was no agreement on the researchers' scores, they resolve the problem with the collective agreement.[19]

Results

Summary of included studies

This review study identified and included 210 review articles related to the field from the literature. These review studies showed indexing in the databases of Scopus, PubMed, ScienceDirect, and CINAHL from October 2019 to January 2020. After the screening process, this review study excluded 160 review studies from the scrutiny process, as these articles did not meet the inclusion criteria. This review focused on the keywords of "Backpack," "Musculoskeletal Injuries," and "Adolescent" from MESH and selected 14 out of 210 articles based on the research objective. According to the Crombie Checklist, inclusion and exclusion criteria, and investigating the quality of the report, this review focused on literature evidence to the field under investigation. The study assessed the remaining 50 studies according to the selected criteria, and only 14 papers met the set standards on the scores between I-a and II-b, based on the classification system of Lloyd–Smith Table 1. In this system, I-a shows none of the selected papers using meta-analysis of randomized controlled trials) RCT(, and I-b presents four of the selected papers. Besides, II-a indicates nine papers (well-designed, nonrandomized studies), and II-b specifies just one article. Tables 1 and 2 shows the details comprehensively.

This review study primarily focused on investigating the effects of the backpack use on musculoskeletal injuries and pain among adolescents' students, and based on the previous studies related to this research, we analyzed the selected papers to find the results. According to the findings and recommendations of the earlier studies, the weight of the backpack should be 10%–15% of the body weights of the adolescents' students. Besides, the findings of the selected studies stipulated that

Table 1: Lloyd- Smith hierarchy of evidence

Level of evidence	Study design	Selected studies
Ia	Meta-analysis of RCT	0
Ib	One individual randomized controlled study	4
IIa	One well-designed, nonrandomized studies	9
IIb	Well-designed quesi-experimental study	1

RCT=Randomized controlled trial

increasing 15% weight of backpacks from students' bodyweights resulted in the deviation of the spine and chronic pains.[16-19] Table 3 demonstrates the results of the selected 14 review studies [Table 4]. The selected studies of the various researchers including Navuluri,[20] and Haselgrove *et al*.,[21] Al Shahry *et al*.,[22] Sharan *et al*.,[23] and Mwaka *et al*.,[9] recommended that the standard approved weight of the backpack should not exceed the defined limits of the body weights to reduce the risks of pains and musculoskeletal injuries among students. Students typically carry backpacks with the openings of their schools as these rucksacks are popular school bags for adolescents during the period of their schooling, and they even use bags after school education.[20]

The findings of the previous studies have shown a relationship between students carrying backpacks and musculoskeletal injuries and shoulder and back pain. The previous studies identified that overweight bags cause musculoskeletal injuries and pains among adolescents, and the weight of the backpacks should not cross the standard limit to avoid health issues among students.[20-22] In a previous study, Talbott recognized that student's body imbalance increases by 20% when they carry overweight backpacks.[24] Since the students carry their heavy bags on daily routine of school-going and half the backpack's weight is because of their textbooks, which leads to various health issues, mainly musculoskeletal deviation and the prevalence of chronic pain. Table 3 illustrates the findings of selected review articles. Besides, Table 2 presents the assessment quality of the selected articles according to the set criteria of this review study. The results of the assessment quality specified that 12 articles out of the 14 indicated moderate scores, and the remaining two articles showed good scores.

Discussion

This review study aimed to examine the impact of heavy backpacks on students and other individuals' health, as overweight backpacks the factors, which cause musculoskeletal injuries and shoulder and back pain among adolescents. This study lasted from October 2019 to January 2020 over 4 months and included the keywords, such as "Backpack," "Musculoskeletal Injuries," and "Adolescent" from MESH to complete the investigation. Based on the study objective, this review initially included 210 articles. This review applied Crombie Checklist, the criteria of inclusion and exclusion, and examined the assessment quality to analyze the results of the selected 14 articles out of 210 in the final phase. The assessment included various published articles across the different parts of the world. These studies examined the effect of the backpack on skeletal pains and injuries among students to highlight the importance of this health issue around the world.

Table 2: Quality appraisal scoring

Quality appraisal item	Paper which fulfilled the criteria
Cleary stated aims	Grimmer *et al*. (2002)[33]
	Navuluri *et al*. (2006)[20]
	Haselgrove *et al*. (2008)[21]
	Siambanes *et al*. (2004)[34]
	Spiteri *et al*. (2017)[35]
	Sharan *et al*. (2012)[23]
	Mwaka *et al*. (2014)[9]
	Al Shahry *et al*. (2018)[22]
	Akbar *et al*. (2019)[25]
	Al-Khabbaz *et al*. (2008)[36]
	Chansirinukor *et al*. (2001)[26]
	Aundhakar *et al*. (2020)[37]
	Syazwan *et al*. (2011)[38]
	Grimmer *et al*. (2000)[31]
Appropriateness of design to meet the aims	Grimmer *et al*. (2002)[33]
	Mwaka *et al*. (2014)[9]
	Aundhakar *et al*. (2020)[37]
	Grimmer *et al*. (2000)[31]
	Al Shahry *et al*. (2018)[22]
	Sharan *et al*. (2012)[23]
	Navuluri *et al*. (2006)[20]
	Mwaka *et al*. (2014)[9]
	Aundhakar*et al*. (2015)[37]
Adequate specifications of subject group given	Grimmer *et al*. (2002)[33]
	Mwaka *et al*. (2014)[9]
Justification of sample size	Mwaka *et al*. (2014)[9]
	Chansirinukor *et al*. (2001)[26]
	Grimmer *et al*. (2002)[33]
Like hood of reliable and valid measurement	Sharan *et al*. (2012)[23]
	Grimmer *et al*. (2002)[33]
Sensitivity of outcome tool	Syazwan *et al*. (2011)[38]
	Al-Khabbaz *et al*. (2008)[36]
	Mwaka *et al*. (2014)[9]
Adequate description of statistical methods	Siambanes et al. (2004)[34]
	Haselgrove *et al*. (2008)[21]
	Grimmer *et al*. (2002)[33]
	Syazwan *et al*. (2011)[38]
	Mwaka *et al*. (2014)[9]
Adequate description of data	Chansirinukor *et al*. (2001)[26]
	Al-Khabbaz *et al*. (2008)[36]
	Akbar *et al*. (2019)[25]
	Al Shahry *et al*. (2018)[22]
	Mwaka *et al*. (2014)[9]
	Navuluri *et al*. (2006)[20]
	Grimmer *et al*. (2002)[33]
	Mwaka *et al*. (2014)[9]
	Syazwan *et al*. (2011)[38]
	Haselgrove *et al*. (2008)[21]
	Siambanes *et al*. (2004)[34]
	Aundhakar*et al*. (2015)[37]
	Grimmer *et al*. (20002)[33]
	Spiteri *et al*. (2017)[35]

Contd...

Table 2: Contd...

Quality appraisal item	Paper which fulfilled the criteria
Consistency in the number of subjects reported through the paper	Mwaka *et al*. (2014)[9]
	Grimmer *et al*. (2000)[31]
	Grimmer *et al*. (2002)[33]
	Aundhakar*et al*. (2015)[37]
	Haselgrove *et al*. (2008)[21]
	Syazwan *et al*. (2011)[38]
	Spiteri *et al*. (2017)[35]
	Navuluri *et al*. (2006)[20]
	Siambanes *et al*. (2004)[34]
	Spiteri *et al*. (2017)[35]
	Al-Khabbaz *et al*. (2008)[36]
Assessment of statistical significance	Syazwan *et al*. (2011)[38]
	Chansirinukor *et al*. (2001)[26]
	Al-Khabbaz *et al*. (2008)[36]
	Mwaka *et al*. (2014)[9]
	Grimmer *et al*. (2000)[31]
	Aundhakar*et al*. (2015)[37]
	Haselgrove *et al*. (2008)[21]
	Siambanes *et al*. (2004)[34]
	Spiteri *et al*. (2017)[35]
	Navuluri *et al*. (2006)[20]
	Grimmer *et al*. (2002)[33]
	Mwaka *et al*. (2014)[9]
	Sharan *et al*. (2012)[23]
	Akbar *et al*. (2019)[25]
	Al Shahry *et al*. (2018)[22]
Attention of potential biases	None
Meaningful main findings	Mwaka *et al*. (2014)[9]
	Grimmer *et al*. (2002)[33]
	Chansirinukor *et al*. (2001)[26]
	Al Shahry *et al*. (2018)[22]
	Akbar *et al*. (2019)[25]
	Sharan *et al*. (2012)[23]
	Navuluri *et al*. (2006)[20]
	Siambanes *et al*. (2004)[34]
	Haselgrove *et al*. (2008)[21]
	Aundhakar*et al*. (2015)[37]
	Grimmer *et al*. (2000)[31]
	Grimmer *et al*. (2002)[33]
	Al-Khabbaz *et al*. (2008)[36]
	Syazwan *et al*. (2011)[38]
	Spiteri *et al*. (2017)[35]
Interpretation of null findings	Chansirinukor *et al*. (2001)[26]
	Grimmer *et al*. (2002)[33]
	Mwaka *et al*. (2014)[9]
	Aundhakar*et al*. (2015)[37]
	Navuluri *et al*. (2006)[20]
	Syazwan *et al*. (2011)[38]
	Al-Khabbaz *et al*. (2008)[36]
	Sharan *et al*. (2012)[23]
	Haselgrove *et al*. (2008)[21]
	Navuluri *et al*. (2006)[20]

Contd...

Table 2: Contd...

Quality appraisal item	Paper which fulfilled the criteria
Interpretation of important effects	Grimmer *et al*. (2002)[33]
	Aundhakar*et al*. (2015)[37]
	Akbar *et al*. (2019)[25]
	Al Shahry *et al*. (2018)[22]
	Al-Khabbaz *et al*. (2008)[36]
	Syazwan *et al*. (2011)[38]
	Siambanes *et al*. (2004)[34]
	Al-Khabbaz *et al*. (2008)[36]
	Grimmer *et al*. (2000)[31]
	Navuluri *et al*. (2006)[20]
	Sharan *et al*. (2012)[23]
Comparison of result with previous reports	Mwaka *et al*. (2014)[9]
	Grimmer *et al*. (2002)[33]
	Chansirinukor *et al*. (2001)[26]
	Al Shahry *et al*. (2018)[22]
	Akbar *et al*. (2019)[25]
	Al-Khabbaz *et al*. (2008)[36]
	Navuluri *et al*. (2006)[20]
	Siambanes *et al*. (2004)[34]
	Haselgrove *et al*. (2008)[21]
	Aundhakar*et al*. (2015)[37]
	Grimmer *et al*. (2000)[31]
	Grimmer *et al*. (2002)[33]
	Sharan *et al*. (2012)[23]
	Syazwan *et al*. (2011)[38]
Implications in real life	Mwaka *et al*. (2014)[9]
	Grimmer *et al*. (2002)[33]

The previous literature identified different factors, which cause musculoskeletal injuries and the prevalence of back and shoulder pains in adolescents' students. The past research recognized the way of using a backpack as the most crucial factor from the previous studies.[23] The review emphasized to examine the effects of heavy backpacks on adolescents causing musculoskeletal injuries and neck and shoulder pains.

This investigation followed different stages and assessed scores of strains and musculoskeletal injuries in students. The findings of the 10 selected review studies revealed the relationship between heavy backpacks, shoulders, and neck pains; however, the results of the other articles showed skeletal disorders, including kyphosis and lordosis, along with shoulders and back pains in the bodies of adolescents. The results of this analysis stipulated that female students were more vulnerable to health issues than males. In this study, relative weight of school bag carried by school girls was significantly high in relation to their body weight. School bag weight and way of carriage have association with girls back pain. A previous study identified that there is a significant relationship between the weight of a backpack and its ratio with body weight and the prevalence of back pain.[25] The intensity of pain were more significant in

Table 3: Characteristics of studies according to the variables studied

Authors, Yeas, Country	Study type	Sample size	Goal	Result
Navuluri *et al*. (2006), USA[20]	Cross-sectional	59	Relationship between backpack use and back and neck pain among adolescents	A higher percentage of girls than boys rated their pain as being moderate to extremely strong. The correlation between pain and backpack weight per body mass index among girls was positive and significant, but negative and nonsignificant among boys
Akbar *et al*. (2019), Kuwait[25]	Cross-sectional	950	Prevalence of low back pain among adolescents in relation to the weight of school bags	LBP among high school students seems to be very common with a prevalence perceived heaviness of school bag is far more important than the actual bag weight
Haselgrove *et al*. (2008), Australian[21]	Cohort	1202	School bag load, duration of carriage, and method of transport to school are associated with spinal pain in adolescents	Perceived school bag load, duration of carriage and method of transport to school are associated with back and neck pain. physical activity in the form of walking or riding to school may offset the potentially provocative effects of prolonged bag carriage
Siambanes *et al*. (2004), USA[34]	Cohort	3005	School backpacks on adolescent back pain	The pain on the back and shoulder was the most prevalent pain in students, and female's complaint more about this pain
Spiteri *et al*. (2017), USA[35]	Cross-sectional	20359	Postural balance and neck angle changes in school children while carrying a traditional backpack versus a double-sided bag	Carrying the double-sided bag restores the body balance and head posture to a condition that is similar to the no load condition
Al Shahry *et al*. (2018), Saudi Arabia[22]	Cross-sectional	200	School bags on body mechanics among Saudi children	Heavy school bags contributed to the presence of pain and shoulder tilt, whereas long duration of carrying school bag did not affect shoulder tilt. Thus, in future, education for parents must be conducted to make sure to prevent students from carrying bags exceeding the acceptable standard limit
Al-Khabbaz *et al*. (2008). Japan[36]	Cross-sectional	250	Backpack heaviness on trunk-lower extremity muscle activities and trunk posture	Abdominis muscle activities increased progressively and disproportionably as the backpack load increased. As for the trunk posture, almost the same backward inclination was adapted even with increasing backpack heaviness
Mwaka *et al*. (2014), Ugandan[9]	Cross-sectional	532	Musculoskeletal pain and school bag use	Almost of the pupils reported having had pain or discomfort Schools need to provide lockers and functional libraries in order to avoid excessive loading and repetitive strain injuries
Grimmer *et al*. (2002), Australian[33]	Experimental	250	Adolescent standing postural response to backpack loads	Neither age nor gender was a significant factor when comparing postural response to Backpack loads or conditions. Backpacks positioned at T7 produced the largest forward (horizontal) displacement at all the anatomical points. The horizontal position of all anatomical points increased linearly with load
Sharan *et al*. (2012)[23]	Retrospective	202	Back pack injuries in Indian school children	Load carried in a backpack shift the center of gravity behind the body in order to compensate this; the body pulls the load forward and thus center of gravity moves over the base of the support in between the feet
Syazwan *et al*. (2011). Malaysia[38]	Experimental	150	Poor sitting posture and a heavy schoolbag as contributors to musculoskeletal pain in children: An ergonomic school education intervention program	Load carried in a backpack shift the center of gravity behind the body in order to compensate this; the body pulls the load forward and thus center of gravity moves over the base of the support in between the feet
Aundhakar*et al*. (2015)[37]	Cross-sectional	626	Back pain in children associated with backpacks	Load carried in a backpack shift the center of gravity behind the body in order to compensate this; the body pulls the load forward and thus center of gravity moves over the base of the support in between the feet
Grimmer *et al*. (2000), Australian[31]	Cross-sectional	48	Gender-age environmental associates of adolescent low back pain	Abdominis muscle activities increased progressively and disproportionably as the backpack load increased. As for the trunk posture, almost the same backward inclination was adapted even with increasing backpack heaviness
Chansirinukor *et al*. (2001), South Australia[26]	Cross-sectional	13	Effects of backpacks on students: Measurement of cervical and shoulder posture	Effects of backpacks on students: Measurement of cervical and shoulder posture

LBP= Low back pain

Table 4: Results of hierarchy of evidence

Author	Hierarchy level	Appraisal score	Quality category
Mwaka *et al*. (2014)[9]	Ib	15.16	High
Grimmer *et al*. (2002)[33]	Ib	15.16	High
Chansirinukor *et al*. (2001)[26]	IIa	7.16	Intermediate
Al Shahry *et al*. (2018)[22]	IIa	7.16	Intermediate
Akbar *et al*. (2019)[25]	Ib	7.16	Intermediate
Al-Khabbaz *et al*. (2008)[36]	IIa	8.16	Intermediate
Navuluri *et al*. (2006)[20]	IIa	10.16	Intermediate
Siambanes *et al*. (2004)[34]	IIa	8.16	Intermediate
Haselgrove *et al*. (2008)[21]	IIa	8.16	Intermediate
Aundhakar*et al*. (2015)[37]	IIa	10.16	Intermediate
Syazwan *et al*. (2011)[38]	IIb	8.16	Intermediate
Sharan *et al*. (2012)[23]	Ib	9.16	Intermediate
Grimmer *et al*. (2002)[33]	IIa	7.16	Intermediate
Spiteri *et al*. (2017)[35]	IIa	6.16	Intermediate

females than male students were, and the time-span of carrying backpacks will increase the intensity of pain.[20-26]

Brackley conducted a study and reported that carrying heavier backpacks exceeding the standard caused a deviation in the spine and pains in the shoulders, neck, and back of the students, in fact wearing a heavy backpack for prolonged periods may cause excessive strain in one's neck, back and shoulder.[27] The findings of this review study are consistent with the previous studies, and the results indicated that backpacks exceeding 10% weight than the standard would cause more neck and shoulder pains and skeletal deviations in students during the study period of elementary school.[28] According to the previous studies conducted by Hong *et al*.[28] and Salehzadeh and Bonab,[29] there was a significant relationship between kyphosis and carrying overweight backpacks exceeding the standard limit. Contrary to this, Ibrahim[30] and Grimmer[31] reported that there was not a significant relationship between back and waist pains in adolescents by carrying backpacks. In a previous study, Palumbo described that adolescents and students' bodies develop some changes in posture to balance the weight and motion when they carry heavy backpacks during their daily traveling to schools and way back to homes.[32] This ability of the students' bodies is in accordance with the outer condition and pressure.[32-38]

Limitation

Concerning the limitations, further cohort investigations might recognize the effects of carrying heavy backpacks that cause the pains in shoulders, neck, and back along with musculoskeletal injuries in adolescents and other students. The review studies in the past literature have not mentioned the ratio of time and pain when students use heavier backpacks. Previous studies have not identified the time ratio and the relationship between pain intensity and musculoskeletal injuries among adolescents. This current review has reminded as a torch because the survey recorded adolescents' body pain and intensity of the pain just for 1–2 weeks. Contrary to this viewpoint, some previous research studies evaluated the larger sample size with adequate research methods, which is the most robust view of the study. Hence, this review study suggests prospective researchers who have interests in this field, to design their studies by considering the strengths and weaknesses. The scholars may examine pain intensity, duration, and time span because of using heavy backpacks. The investigators may design their questionnaires based on the documents instead of memories of the target samples to minimize the possibility of biased results.

Conclusion

The main emphasis of this review study was to explore the effects of overweight backpacks on adolescent's health, as heavy bags cause musculoskeletal injuries and shoulder and back pains. This review initially selected 210 research papers by applying Crombie Checklist. Based on the results of this investigation, backpacks weight and bags standard weight effects on students' health provide exciting findings; however, the relationship between overweight backpacks effects and students' body postural changes are still inconsistent in the past literature. Hence, backpacks' base support should be narrow to alert the body posture, and the center of gravity must move beyond the base of the backpacks' support.

When students carry backpacks over 15% of their body weight, it causes various health issues, such as neck, shoulders, and back pains along with musculoskeletal injuries. In accordance with the findings of this research and its systematic review, the study concludes that backpack weight should be 10% of the student's body weight to save them from different health problems. This study recommends useful insight to use standard backpacks in schools to reduce the weight burden on adolescents' spine, and this effort will help to develop a healthier and pain-free student population in the future. The researcher can use RCTs and meta-analysis to determine backpack weight effects on the body posture of adolescents and students. The outlines of this review study identified the areas that require further attention to include RCT, subject group's appropriate specification with justified sample size to gain exciting results to generalize the study findings to the real life.

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Conflicts of interest
There are no conflicts of interest.

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