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# Screening for Adolescent Idiopathic Scoliosis

## US Preventive Services Task Force

### Recommendation Statement

US Preventive Services Task Force

**IMPORTANCE** Adolescent idiopathic scoliosis, a lateral curvature of the spine of unknown cause with a Cobb angle of at least 10°, occurs in children and adolescents aged 10 to 18 years. Idiopathic scoliosis is the most common form and usually worsens during adolescence before skeletal maturity. Severe spinal curvature may be associated with adverse long-term health outcomes (eg, pulmonary disorders, disability, back pain, psychological effects, cosmetic issues, and reduced quality of life). Early identification and effective treatment of mild scoliosis could slow or stop curvature progression before skeletal maturity, thereby improving long-term outcomes in adulthood.

**OBJECTIVE** To update the 2004 US Preventive Services Task Force (USPSTF) recommendation on screening for idiopathic scoliosis in asymptomatic adolescents.

**EVIDENCE REVIEW** The USPSTF reviewed the evidence on the benefits and harms of screening for and treatment of adolescent idiopathic scoliosis.

**FINDINGS** The USPSTF found no direct evidence on screening for adolescent idiopathic scoliosis and health outcomes and no evidence on the harms of screening. The USPSTF found inadequate evidence on treatment with exercise and surgery. It found adequate evidence that treatment with bracing may slow curvature progression in adolescents with mild or moderate curvature severity (Cobb angle <40° to 50°); however, evidence on the association between reduction in spinal curvature in adolescence and long-term health outcomes in adulthood is inadequate. The USPSTF found inadequate evidence on the harms of treatment. Therefore, the USPSTF concludes that the current evidence is insufficient and that the balance of benefits and harms of screening for adolescent idiopathic scoliosis cannot be determined.

**CONCLUSIONS AND RECOMMENDATION** The USPSTF concludes that the current evidence is insufficient to assess the balance of benefits and harms of screening for adolescent idiopathic scoliosis in children and adolescents aged 10 to 18 years. (I statement)

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**T**he US Preventive Services Task Force (USPSTF) makes recommendations about the effectiveness of specific preventive care services for patients without obvious related signs or symptoms.

It bases its recommendations on the evidence of both the benefits and harms of the service and an assessment of the balance. The USPSTF does not consider the costs of providing a service in this assessment.

The USPSTF recognizes that clinical decisions involve more considerations than evidence alone. Clinicians should understand the evidence but individualize decision making to the specific patient or situation. Similarly, the USPSTF notes that policy and coverage decisions involve considerations in addition to the evidence of clinical benefits and harms.

## Summary of Recommendation and Evidence

The USPSTF concludes that the current evidence is insufficient to assess the balance of benefits and harms of screening for adolescent idiopathic scoliosis in children and adolescents aged 10 to 18 years (I statement) (Figure 1).

## Rationale

### Importance

Adolescent idiopathic scoliosis is a lateral curvature of the spine of unknown cause with a Cobb angle (a measure of the curvature of

Figure 1. US Preventive Services Task Force (USPSTF) Grades and Levels of Certainty

What the USPSTF Grades Mean and Suggestions for Practice		
Grade	Definition	Suggestions for Practice
A	The USPSTF recommends the service. There is high certainty that the net benefit is substantial.	Offer or provide this service.
B	The USPSTF recommends the service. There is high certainty that the net benefit is moderate, or there is moderate certainty that the net benefit is moderate to substantial.	Offer or provide this service.
C	The USPSTF recommends selectively offering or providing this service to individual patients based on professional judgment and patient preferences. There is at least moderate certainty that the net benefit is small.	Offer or provide this service for selected patients depending on individual circumstances.
D	The USPSTF recommends against the service. There is moderate or high certainty that the service has no net benefit or that the harms outweigh the benefits.	Discourage the use of this service.
I statement	The USPSTF concludes that the current evidence is insufficient to assess the balance of benefits and harms of the service. Evidence is lacking, of poor quality, or conflicting, and the balance of benefits and harms cannot be determined.	Read the Clinical Considerations section of the USPSTF Recommendation Statement. If the service is offered, patients should understand the uncertainty about the balance of benefits and harms.

USPSTF Levels of Certainty Regarding Net Benefit	
Level of Certainty	Description
High	The available evidence usually includes consistent results from well-designed, well-conducted studies in representative primary care populations. These studies assess the effects of the preventive service on health outcomes. This conclusion is therefore unlikely to be strongly affected by the results of future studies.
Moderate	The available evidence is sufficient to determine the effects of the preventive service on health outcomes, but confidence in the estimate is constrained by such factors as the number, size, or quality of individual studies. inconsistency of findings across individual studies. limited generalizability of findings to routine primary care practice. lack of coherence in the chain of evidence. As more information becomes available, the magnitude or direction of the observed effect could change, and this change may be large enough to alter the conclusion.
Low	The available evidence is insufficient to assess effects on health outcomes. Evidence is insufficient because of the limited number or size of studies. important flaws in study design or methods. inconsistency of findings across individual studies. gaps in the chain of evidence. findings not generalizable to routine primary care practice. lack of information on important health outcomes. More information may allow estimation of effects on health outcomes.
The USPSTF defines certainty as “likelihood that the USPSTF assessment of the net benefit of a preventive service is correct.” The net benefit is defined as benefit minus harm of the preventive service as implemented in a general, primary care population. The USPSTF assigns a certainty level based on the nature of the overall evidence available to assess the net benefit of a preventive service.	

the spine) of at least 10° that occurs in children and adolescents aged 10 to 18 years. It is the most common form of scoliosis and usually worsens during adolescence before skeletal maturity. In the United States, the estimated prevalence of adolescent idiopathic scoliosis with a Cobb angle of at least 10° among children and adolescents aged 10 to 16 years is 1% to 3%.<sup>1,2</sup> Most patients with a spinal curvature of greater than 40° at skeletal maturity will likely experience curvature progression in adulthood. Severe spinal curvature may be associated with adverse long-term health outcomes (eg, pulmonary disorders, disability, back pain, psychological effects, cosmetic issues, and reduced quality of life).<sup>1,3</sup> Therefore, early identification and effective treatment of mild scoliosis could slow or stop

curvature progression before skeletal maturity, thereby improving long-term outcomes in adulthood.

**Detection**

The USPSTF found adequate evidence that currently available screening tests can accurately detect adolescent idiopathic scoliosis. The accuracy of screening was highest (93.8% sensitivity and 99.2% specificity) when 3 separate screening tests were used (eg, the forward bend test, scoliometer measurement, and Moiré topography); sensitivity was lower when screening programs used just 1 or 2 screening tests (eg, 71.1% for the forward bend test and scoliometer measurement and 84.4% for the forward bend test alone).

Figure 2. Clinical Summary: Screening for Adolescent Idiopathic Scoliosis

Population	Children and adolescents aged 10 to 18 y
Recommendation	No recommendation. Grade: I (insufficient evidence)
Excluded Populations	This recommendation does not apply to children and adolescents presenting for evaluation of back pain or obvious deformities in spinal curvature.
Screening Tests	Adequate evidence indicates that currently available screening tests can accurately detect adolescent idiopathic scoliosis when used in combination. Radiography is used to confirm the diagnosis and also to quantify the degree of curvature (ie, the Cobb angle); the Risser sign (the stage of ossification of the iliac apophysis) is used to monitor curve progression.
Treatments	Information about the benefits or harms of treatment of screen-detected adolescent idiopathic scoliosis is inadequate. Treatment is determined by the degree of spinal curvature and the potential for further skeletal growth, and may include observation, exercise, bracing, or surgery.

For a summary of the evidence systematically reviewed in making this recommendation, the full recommendation statement, and supporting documents, please go to <https://www.uspreventiveservicestaskforce.org>.



**Benefits of Early Detection and Intervention or Treatment**

The USPSTF found no direct evidence regarding the effect of screening for adolescent idiopathic scoliosis on patient-centered health outcomes. The USPSTF found inadequate evidence on the treatment of idiopathic scoliosis (Cobb angle <50° at diagnosis) in adolescents with exercise (2 small studies) or surgery (no studies) or its effects on health outcomes or the degree of spinal curvature in childhood or adulthood. The USPSTF found adequate evidence (5 studies) that treatment with bracing may decrease curvature progression in adolescents with mild or moderate curvature severity (an intermediate outcome). However, it found inadequate evidence on the association between reduction in spinal curvature in adolescence and long-term health outcomes in adulthood.

**Harms of Early Detection and Intervention or Treatment**

The USPSTF found no studies on the direct harms of screening, such as psychological harms or harms associated with confirmatory radiography. The USPSTF found inadequate evidence to determine the harms of treatment.

**USPSTF Assessment**

The USPSTF concludes that the current evidence is insufficient and that the balance of benefits and harms of screening for adolescent idiopathic scoliosis cannot be determined.

**Clinical Considerations**

**Patient Population Under Consideration**

This recommendation applies to asymptomatic children and adolescents aged 10 to 18 years (Figure 2). This recommendation does not apply to children and adolescents presenting for evaluation of back pain, breathing difficulties, abnormal radiography findings or other imaging studies, or obvious deformities in spinal curvature.

**Screening Tests**

Most screening tests for adolescent idiopathic scoliosis are non-invasive. Screening is usually done by visual inspection of the spine to look for asymmetry of the shoulders, shoulder blades, and hips. In the United States, the forward bend test is commonly used to screen for idiopathic scoliosis. First, a clinician visually inspects the spine of a patient while the patient is standing upright. Next, the patient stands with feet together and bends forward at the waist with arms hanging and palms touching. The clinician repeats the visual inspection of the spine.<sup>1,4</sup> A scoliometer, which measures the angle of trunk rotation, may be used during the forward bend test. An angle of trunk rotation of 5° to 7° is often the threshold for referral for radiography.<sup>1</sup> Other screening tests include a humpometer, the plumb line test, and Moiré topography (creating a 3-dimensional image of the surface of a patient’s back) (Table).

If idiopathic scoliosis is suspected, radiography is used to confirm the diagnosis and to quantify the degree of curvature (ie, the Cobb angle) and the Risser sign (the stage of ossification of the iliac apophysis).<sup>1</sup> US organizations that advocate screening recommend the forward bend test combined with scoliometer measurement.

**Treatment**

The goal of treatment is to decrease or stop progression of spinal curvature during the period of adolescent growth prior to skeletal maturity. Treatment of adolescent idiopathic scoliosis is determined by the degree of spinal curvature and the potential for further growth and generally includes observation, bracing, surgery, and exercise.<sup>1</sup>

**Suggestions for Practice Regarding the I Statement**

**Potential Preventable Burden**

Most children and adolescents with scoliosis do not have symptoms. Generally, smaller spinal curvatures remain stable, while larger curvatures tend to progress in severity.

Table. Screening Tests for Adolescent Idiopathic Scoliosis

Screening Test	Description
Forward bend test	The child bends forward at the waist until the spine is parallel to the horizontal plane. The examiner checks the child's back for rib humps or other spinal asymmetries. This test is commonly used in school-based scoliosis screening programs, with or without a scoliometer.
Scoliometer	A noninvasive, handheld instrument used to measure the angle of trunk rotation. The examiner places the instrument on the child's spine during the forward bend test and reads the angle. An angle of trunk rotation of 5° to 7° is the recommended threshold for referral to radiography.
Humpometer	A series of movable strips are placed along the child's back perpendicular to the spine. The examiner locks the strips into place, transfers the contour lines to graph paper, adds the size of rib humps and depressions, and obtains a measure of back deformity. A back deformity of ≥5 mm may indicate a positive screening result.
Plumb line test	The examiner holds a plumb line at the child's C7 vertebra (in the neck) while the child is standing upright and allows the line to hang below the hips. The amount to which the plumb line moves from the center of the spine is measured.
Moiré topography	A specialized device projects contour lines, called Moiré fringes, on the child's back. The examiner takes a photograph of this projection and counts the number of asymmetric contour lines. A child with ≥2 asymmetric Moiré fringes is usually referred to radiography.

Pulmonary dysfunction can be clinically significant in patients with spinal curvatures greater than 100°; however, curvatures of that severity are rare. Back pain is more common, but its effect on functioning or disability is unclear.<sup>1</sup> Current evidence suggests that the presence of back pain does not necessarily correlate with the degree of spinal curvature in adulthood. Adults with adolescent idiopathic scoliosis may have poor self-reported health, appearance, and social interactions. Mortality is similar to that among unaffected adults.<sup>1</sup>

#### Potential Harms

Evidence on the harms of screening for adolescent idiopathic scoliosis is limited. False-positive results are an important potential harm, with rates ranging from 0.8% to 21.5%.<sup>1,5,6</sup> However, the direct harms of screening are unclear. Potential harms of false-positive results include unnecessary follow-up visits, increased cancer risk attributable to radiation exposure, overtreatment with bracing, or psychosocial effects associated with the diagnosis of clinically nonsignificant scoliosis.<sup>1</sup>

#### Current Practice

Various organizations have recommended routine screening for scoliosis in children and adolescents since the 1980s.<sup>1,4</sup> More than half of US states either mandate or recommend school-based screening for scoliosis.<sup>1,4,7</sup> Children and adolescents are usually screened with the forward bend test, with or without scoliometer measurement.<sup>1,4</sup>

In general, patients with a Cobb angle of less than 20° are observed without treatment; however, exercise may be recommended at this time. Patients with a Cobb angle greater than 30° or a Cobb angle of 20° to 30° that progresses 5° or more over 3 to 6 months are treated with bracing. Patients with a Cobb angle of 40° to 50° may be treated with bracing or surgery, while those with a Cobb angle greater than 50° typically require surgery.<sup>1</sup>

## Other Considerations

### Research Needs and Gaps

The USPSTF identified several research gaps. Prospective, controlled screening studies that allow for comparison of screened and nonscreened populations and different screening settings, personnel, and procedures are needed. Good-quality studies with prospective identification of cohorts at the time of diagnosis (eg, from

geographical areas with and without routine screening for adolescent idiopathic scoliosis) or treatment (eg, treated vs observed cohorts) for the purpose of long-term follow-up are important. High-quality studies on the potential harms of screening and treatment are also needed. Additional studies to help determine whether individual characteristics (eg, body mass index) may influence response to bracing treatment would be helpful. Studies on long-term outcomes are needed and should stratify results by degree of spinal curvature at diagnosis and at skeletal maturity. Better information on long-term outcomes such as pulmonary disorders, disability, back pain, psychological effects, cosmetic issues, and quality of life would be helpful. Good-quality studies on treatment with exercise, bracing, and surgery among screen-detected patients are needed. Studies conducted in primary care settings are also needed.

## Discussion

### Burden of Disease

The prevalence of adolescent idiopathic scoliosis (defined as a Cobb angle ≥10°) ranges from 1% to 3% among children and adolescents aged 10 to 16 years.<sup>1,2</sup> Cumulative incidence estimates for spinal curvature of greater severity are 1.0% (Cobb angle ≥20°) and 0.4% (Cobb angle ≥40°). Prevalence varies by sex, ranging from 0.15% to 0.66% in boys and from 0.24% to 3.10% in girls.<sup>1</sup> Prevalence of scoliosis with a Cobb angle of 10° is similar among girls and boys, but girls are 10 times more likely than boys to progress to a Cobb angle of 30° or greater. Girls are also 5 times more likely than boys to have a Cobb angle of 20° or greater.<sup>1</sup> The adverse effects of progressive scoliosis vary depending on its severity and include treatment costs, cosmetic deformity, reduced quality of life, disability, chronic back pain, social and psychological effects, functional limitations, and pulmonary disorders.<sup>1</sup>

### Scope of Review

To update its 2004 recommendation, the USPSTF reviewed the evidence on the benefits and harms of screening for and treatment of adolescent idiopathic scoliosis.<sup>8</sup>

### Accuracy of Screening Tests

Seven fair-quality observational studies assessed screening in adolescents (n = 447 243).<sup>1</sup> Four studies evaluated the forward bend test

with scoliometer measurement, 1 study evaluated the forward bend test with scoliometer measurement and Moiré topography, 1 study evaluated screening with a series of single, independent tests (forward bend test, Moiré topography, scoliometer, or humpometer), and 1 study evaluated the forward bend test with a level plane and ruler. Studies were conducted in 7 different international sites, including 1 in the United States. Other countries included Singapore, Hong Kong, Greece, Ireland, and Norway. Six studies were conducted in school-based settings.<sup>1</sup> There was heterogeneity in the screening approaches, screening procedures, and training of the screeners (eg, orthopedists, nurses, and physical education teachers). Studies provided a limited description of screening populations and subgroups; 3 studies had follow-up data on children who screened negative. Five studies reported results of a single screening episode; 2 studies reported cumulative results of multiple years of repeated screening.<sup>1</sup> Studies used a Cobb angle of 10° or greater of the major spinal curvature as the threshold for a diagnosis of scoliosis.<sup>1</sup>

Screening accuracy improved with the number of screening tests used. Sensitivity and positive predictive value of screening programs varied based on whether a single or multiple screening tests were used and by the selected threshold for a positive screening result.

#### Sensitivity and Specificity

Screening with a combination of the forward bend test, scoliometer measurement, and Moiré topography had the highest sensitivity (93.8% [95% CI, 93.3%-94.3%]) and specificity (99.2% [95% CI, 99.2%-99.2%]).<sup>9-11</sup> The forward bend test combined with scoliometer measurement had lower screening accuracy (71.1% sensitivity [95% CI, 54.1%-84.6%] and 97.1% specificity [95% CI, 96.3%-97.7%]).<sup>5</sup> The forward bend test alone had 84.4% sensitivity (95% CI, 67.2%-94.7%) and 95.2% specificity (95% CI, 94.3%-95.9%), the humpometer had 93.8% sensitivity (95% CI, 79.2%-99.2%) and 78.5% specificity (95% CI, 76.9%-80.0%), the scoliometer had 90.6% sensitivity (95% CI, 75.0%-98.0%) and 80.7% specificity (95% CI, 79.1%-82.1%), and Moiré topography had 100% sensitivity (95% CI, 84.2%-100%) and 85.4% specificity (95% CI, 84.0%-86.7%).<sup>6</sup>

#### False-Positive and False-Negative Results

One study evaluated screening with a combination of the forward bend test, scoliometer measurement, and Moiré topography and reported a low false-negative rate (6.2%) and the lowest false-positive rate (0.8%).<sup>1,6,11</sup> One study of the forward bend test combined with scoliometer measurement reported a 2.9% false-positive rate and a 28.9% false-negative rate.<sup>5</sup> Single screening tests were associated with the highest false-positive rates (forward bend test, 4.8% [15.6% false-negative rate]; scoliometer, 19.3% [9.4% false-negative rate]; Moiré topography, 14.6% [0% false-negative rate]; humpometer, 21.5% [6.3% false-negative rate]).<sup>1,6</sup>

#### Positive Predictive Value

Screening with a combination of the forward bend test, scoliometer measurement, and Moiré topography had the highest positive predictive value (81.0% [95% CI, 80.3%-81.7%]).<sup>9-11</sup> Positive predictive values for the forward bend test combined with scoliometer measurement ranged from 29.3% (95% CI, 20.3%-39.8%)<sup>5</sup> to 54.1% (95% CI, 40.8%-66.9%)<sup>12-14</sup> and from 5.0% (95% CI, 3.4%-

7.0%) to 17.3% (95% CI, 11.7%-24.2%) for a single screening test (ie, humpometer or the forward bend test alone).<sup>1,6</sup>

### Effectiveness of Early Detection and Intervention or Treatment

#### Bracing

The USPSTF found 7 studies on the effectiveness of treatment of adolescent idiopathic scoliosis. Five studies (n = 651) evaluated the effectiveness of 3 different types of braces. The 5 studies included 3 trials (1 fair-quality randomized clinical trial [RCT] and 1 fair-quality and 1 good-quality controlled clinical trial [CCT] [n = 347])<sup>15-18</sup> and 2 observational studies (1 good-quality prospective observational study and 1 fair-quality retrospective observational study [n = 304]).<sup>19,20</sup> Two trials were stopped early for observation of benefit. The good-quality CCT began as an RCT but was changed to a patient preference controlled trial to boost enrollment after low acceptance of random assignment.<sup>1,17,18</sup>

Studies included a comparison group that originally was not treated with bracing and had a prespecified clinical threshold for initiation of treatment. Three studies enrolled participants who had not previously received treatment for scoliosis; 2 studies did not provide details on prior treatment. Study sample sizes ranged from 37 to 242 participants. Studies were conducted in 5 countries (Canada, Sweden, United Kingdom, Ireland, and United States).<sup>1</sup>

Study participants were recruited from specialty orthopedic centers and school screening programs. Average age at study enrollment was 12 to 13 years. Race/ethnicity was inconsistently reported; in the 1 trial in which it was reported, 78% of participants were white. Most participants were female. Study participants had various types of scoliotic curvatures; curvature severity varied from a Cobb angle of about 20° to 30°. Eighty-five percent of participants had not reached skeletal maturity (defined as a Risser sign of 0-2).<sup>1</sup>

Three controlled prospective studies (n = 345) suggested a benefit of treatment with bracing on slowing curvature progression of 5° or 6° compared with observed controls<sup>3,15,16,19</sup>; 1 prospective study (n = 37) and 1 retrospective study (n = 64) showed limited differences in curvature progression of 10° or more between treatment groups and observation control groups.<sup>3,14,16</sup> Four studies (n = 411) evaluated curvature progression to a degree considered to be failure of treatment.<sup>11,16,20,21</sup> The largest of these studies (n = 242) demonstrated a significant benefit associated with bracing.<sup>17,18</sup> The RCT (n = 68) suggested less curvature progression in the treatment group, but the significance was not reported.<sup>3,15</sup> Two smaller studies (n = 101) found similar results between treated and control populations.<sup>3,12,16</sup>

The aforementioned large study (n = 242) was a good-quality, international CCT (Bracing in Adolescent Idiopathic Scoliosis Trial [BrAIST]) that evaluated the effectiveness of bracing for 18 hours per day.<sup>18</sup> The study included a randomized cohort (n = 116) and a preference cohort (n = 126). The study conducted intention-to-treat and as-treated analyses. The rate of treatment success in the as-treated analysis (which included both cohorts) was 72% in the intervention group and 48% in the control group (odds ratio, 1.93 [95% CI, 1.08-3.46]).<sup>1,3,18</sup> In the intention-to-treat analysis (which included the randomized cohort only), the rate of treatment success was 75% in the intervention group and 42% in the control group (odds ratio, 4.11 [95% CI, 1.85-9.16]).<sup>1,3,18</sup> The number needed to treat to prevent 1 case of curvature progression past 50° was 3.0 (95%



CI, 2.0-6.2), and the reduction in relative risk with bracing was 56% (95% CI, 26%-82%).<sup>1,3,18</sup> BraIST was the only study that reported quality-of-life outcomes associated with bracing; outcomes were similar between treatment groups.

One study, the Scoliosis Research Society (SRS) bracing cohort, assessed Cobb angle in adulthood.<sup>19,20</sup> Of the original 106 participants enrolled at 2 centers in the SRS bracing cohort, 77 were re-evaluated as adults (mean age, 32 years). The study demonstrated that the average Cobb angle at skeletal maturity was similar in the observed and treated groups (30.6° vs 27.7°, respectively;  $P = .067$ ). At follow-up in adulthood, the average Cobb angle had increased by an average of 4.4° (SD, 4.1°) in observed participants and by 6.4° (SD, 5.8°) in treated participants. Only 7.5% of observed participants and 5.4% of treated participants had curvature progression past 45° at the time of follow-up ( $P > .99$ ).<sup>1,3</sup>

### Exercise

Two Italian trials ( $n = 184$ ) evaluated the effectiveness of exercise treatment (tailored physiotherapeutic, scoliosis-specific exercise).<sup>21,22</sup> The trials used control groups in which participants were assigned to an exercise program not designed to specifically treat scoliosis. Trial participants had a Cobb angle ranging from 10° to 25°; skeletal maturity ranged from a Risser sign of 0 to 3. Patients were older than 10 years.<sup>1</sup>

In the good-quality RCT ( $n = 110$ )<sup>21</sup> and the fair-quality CCT ( $n = 74$ ),<sup>22</sup> the intervention group showed significant improvement compared with a generic exercise control group at the 12-month follow-up. In the RCT, intervention group participants had a Cobb angle reduction of 4.9°, compared with an increase of 2.8° in the control group ( $P < .001$ ).<sup>1,3,21,22</sup> Quality-of-life measures improved at 12 months in the intervention group compared with marginal improvements or unchanging measures in the control group. At the end of the 12-month treatment period in the CCT, the intervention group had a decrease of 0.67° in average magnitude of all spinal curvatures compared with an increase of 1.38° in the control group ( $P < .05$ ).<sup>1,3,21,22</sup>

### Surgery

The USPSTF found no studies of surgical treatment in screening-relevant populations that met inclusion criteria.

### Association Between Adolescent Spinal Curvature Severity and Adult Health Outcomes

The USPSTF found no studies that directly addressed whether changes in the severity of spinal curvature in adolescence results in changes in adult health outcomes. The USPSTF found no studies that reported health outcomes stratified by degree of spinal curvature at skeletal maturity. Two fair-quality studies provided data on adult health outcomes, stratified by the type of treatment received in adolescence.<sup>1,3,23-25</sup>

The USPSTF considered 2 fair-quality retrospective observational long-term follow-up analyses ( $n = 339$ ) of adults diagnosed with idiopathic scoliosis in adolescence.<sup>1,3,23-25</sup> Adult outcomes were stratified by the type of treatment received in adolescence (bracing or surgery). Quality of life, as measured by the Scoliosis Research Society 22 (SRS-22) Patient Questionnaire or the 36-Item Short-Form Health Survey, was not significantly different between observed and treated participants at follow-up in adult-

hood. No significant differences were found between braced and surgically treated participants in the Oswestry Disability Index or in general well-being, self-esteem, and social activity. Pulmonary and pregnancy outcomes were also not significantly different between braced and surgically treated participants. However, braced participants rated their body appearance as more distorted than did untreated participants and reported more negative treatment experiences than those treated with surgery.<sup>1,3,23-25</sup>

### Potential Harms of Screening and Treatment

The USPSTF found no studies on the direct harms of screening for adolescent idiopathic scoliosis. False-positive rates ranged from 0.8% for the forward bend test combined with scoliometer measurement and Moiré topography to 21.5% for hump assessment alone. Potential harms associated with false-positive results include psychological harms, chest radiation, and other harms of unnecessary treatment.

Potential harms of bracing include skin problems, body pain, physical limitations, anxiety, and depression. Complications of surgery include bleeding, infection, nerve damage, and death. The USPSTF found no studies that assessed the harms of treatment with surgery or exercise. Harms of bracing were reported in 1 good-quality study ( $n = 242$ ).<sup>17,18</sup> In this RCT, intervention group participants were more likely to experience skin problems under the brace than control group participants (12/146 vs 0/96, respectively). Intervention group participants more commonly reported nonback body pain than control group participants (12/146 vs 2/96, respectively). The study reported low rates of anxiety and depression. Three of 146 participants in the intervention group reported anxiety and depression compared with 1 of 96 participants in the control group. One of the intervention group participants reported a serious adverse event (anxiety and depression requiring hospitalization), compared with no participants in the control group. The intervention and control groups had similar rates of abnormal breast development, neurologic symptoms, and gastrointestinal or respiratory symptoms.<sup>17,18</sup>

### Estimate of Magnitude of Net Benefit

The USPSTF found no direct evidence on screening for adolescent idiopathic scoliosis and health outcomes. The USPSTF found adequate evidence that currently available screening tests can detect adolescent idiopathic scoliosis but no evidence on the harms of screening. The USPSTF found inadequate evidence on treatment with exercise and surgery; it found adequate evidence that treatment with bracing may slow curvature progression in adolescents with mild or moderate curvature severity. However, the USPSTF found inadequate evidence on the association between reduction in spinal curvature in adolescence and long-term health outcomes in adulthood. The USPSTF found inadequate evidence on the harms of treatment. Therefore, the USPSTF concludes that the current evidence is insufficient and that the balance of benefits and harms of screening for adolescent idiopathic scoliosis cannot be determined.

### How Does Evidence Fit With Biological Understanding?

Mild or moderate idiopathic scoliosis (ie, Cobb angle of <40° to 50°) is often asymptomatic in adolescence. In addition, the majority of cases of scoliosis will not substantially progress during

adolescence. The likelihood of progression in adulthood is small for persons with a spinal curvature of less than 30° at skeletal maturity. However, there is no validated way to easily identify which cases of asymptomatic scoliosis will worsen during adolescence and lead to poor long-term outcomes.

### Response to Public Comment

A draft version of this recommendation statement was posted for public comment on the USPSTF website from May 30 to June 26, 2017. Many comments expressed concern about the change in letter grade (from a D grade to an I statement). In response, the USPSTF added language in the "Update of Previous USPSTF Recommendation" section to explain the change in grade. Some comments sought clarification of who the recommendation applies to. The USPSTF clarified this in the "Patient Population Under Consideration" section. Other comments expressed concern that the evidence needed to change the recommendation grade is unattainable. The USPSTF added language to address this in the "Research Needs and Gaps" section.

### Update of Previous USPSTF Recommendation

This recommendation updates the 2004 USPSTF recommendation, in which the USPSTF recommended against routine screening for idiopathic scoliosis in asymptomatic adolescents (D recommendation).<sup>8</sup> In 2004, the USPSTF found fair evidence that treatment of adolescent idiopathic scoliosis leads to health benefits (ie, decreased pain and disability) in a small proportion of persons. The USPSTF bounded the harms of treatment as moderate (eg, unnecessary brace wear or unnecessary referral to specialty care). Therefore, at that time, the USPSTF concluded that the harms of screening exceeded the potential benefits.<sup>8</sup>

To update its recommendation, the USPSTF commissioned a systematic review of the evidence. Because of new research,

the USPSTF determined that it no longer has moderate certainty that the harms of treatment outweigh the benefits. The USPSTF found no direct evidence of a benefit of screening for adolescent idiopathic scoliosis on health outcomes. A growing body of evidence suggests that brace treatment can interrupt or slow scoliosis progression; however, evidence on whether reducing spinal curvature in adolescence has a long-term effect on health in adulthood is inadequate. Evidence on the effects of exercise and surgery on health or spinal curvature in childhood or adulthood is insufficient. Although the USPSTF previously found that treatment has moderate harms, a change in the analytic framework, outcomes, and applicability of older evidence resulted in the USPSTF assessing the evidence on harms of treatment as inadequate. As a result, the USPSTF has determined that the current evidence is insufficient to assess the balance of benefits and harms of screening for adolescent idiopathic scoliosis, leading the USPSTF to issue an I statement.

### Recommendations of Others

Several national specialty groups have published statements in support of screening. The American Academy of Orthopaedic Surgeons, the Scoliosis Research Society, the Pediatric Orthopaedic Society of North America, and the American Academy of Pediatrics advocate screening for scoliosis in girls at 10 and 12 years and once in male adolescents at 13 or 14 years as part of medical home preventive services, if screening is performed by well-trained screening personnel.<sup>26</sup> The UK National Screening Society does not recommend screening for scoliosis, given the uncertainty surrounding the effectiveness of screening and treatment.<sup>27</sup> However, the International Society on Scoliosis Orthopaedic and Rehabilitation Treatment recommends screening for idiopathic scoliosis through school-based programs, and that screening should be performed by clinicians who specialize in spinal deformities.<sup>28</sup>

#### ARTICLE INFORMATION

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