

# Objective Predictors of Grit, Self-Control, and Conscientiousness in Orthopaedic Surgery Residency Applicants

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## Abstract

**Introduction:** The purpose of this study was to identify objective predictors of grit, self-control, and conscientiousness in orthopaedic surgery residency applicants.

**Methods:** The following attributes were assessed in 455 applicants: grit, self-control, conscientiousness, consistency of interest, perseverance of effort, and ambition. These measures were correlated with standard, objective demographics obtained during the application process.

**Results:** Alpha Omega Alpha status, additional degrees, and number of publications did not predict any of the studied attributes. Grit increased with age ( $P < 0.001$ ) but decreased with increasing board scores ( $P = 0.004$ ). Former collegiate athletes demonstrated greater grit ( $P < 0.001$ ), consistency of interest ( $P = 0.007$ ), perseverance ( $P = 0.006$ ), and self-control ( $P = 0.019$ ). Female applicants demonstrated more grit ( $P = 0.044$ ), consistency of interest ( $P = 0.003$ ), and conscientiousness ( $P = 0.029$ ) than males. Applicants with military experience had increased ambition ( $P = 0.033$ ) and conscientiousness ( $P = 0.001$ ).

**Conclusion:** Overall, orthopaedics applicants possess increased grit compared with the general public, and a number of objective variables reliably predicted the studied attributes.

**Level of Evidence:** Level III, Cross-sectional study

In recent years, particularly since the introduction of the 80-hour workweek, the number of applicants for orthopaedic surgery residency has increased annually.<sup>1</sup> During this time, the number of available positions has remained relatively stable, which has resulted in an increasingly competitive application process for medical students in which 28% (287 of 1,013) of orthopaedic applicants went unmatched in 2017.<sup>1-4</sup> As a result, the mean United States Medical Licensing Examination (USMLE) Step 1 scores and academic produc-

tivity (number of publications) of applicants are on the rise.<sup>5</sup> Concurrent with this trend of heightened academic qualifications of applicants, a great deal of effort has been dedicated to identifying other factors that may predict future success in orthopaedic surgery residency. These factors include, but are not limited to, Alpha Omega Alpha (AOA) honor society status, class rank, clinical grades, military status, athletic achievement, letters of recommendation, orthopaedic clerkship evaluations, and performance on interview day.<sup>3,6-10</sup> Although many

of these provide objective measures of applicant aptitude, most fall short of reliably predicting future resident and surgeon success. Although the cognitive, academic measures (eg, USMLE scores, grades, AOA status) reliably predict future academic and testing performance,<sup>8,11,12</sup> these data points tell us very little about critical, “noncognitive” variables such as interpersonal skills, self-control, moral reasoning, and conscientiousness.<sup>3,13,14</sup> These variables are often termed psychometric and can be very difficult to quantify.

One noncognitive variable that has gained notable attention recently is “grit,” which is defined by Duckworth et al<sup>15</sup> as steadfast passion and perseverance for long-term goals, particularly in the setting of hardship and setbacks. Outside of the medical community, grit scores (ie, compiled from a grit scale questionnaire) have demonstrated a consistent ability to predict graduation rates for cadets in the US Military Academy, advancement to the final rounds of the Scripps National Spelling Bee, graduation rates for at-risk students in inner-city high schools, and productivity for individuals in the sales industry.<sup>15-18</sup> Within the medical community, higher grit scores have correlated with greater surgical resident well-being,<sup>19</sup> lower surgical resident attrition rates,<sup>20,21</sup> decreased burn-out for attending surgeons,<sup>22</sup> and higher rates of career satisfaction for rural physicians.<sup>23</sup> Along with grit, two other traits known to correlate with future academic and personal success are self-control and conscientiousness.<sup>24,25</sup> Previous work has demonstrated that learners with greater degrees of self-control obtain higher grades, display more professional behavior, are less likely to abuse alcohol, have better interpersonal relationships, and react with more optimal emotional responses.<sup>24</sup> Similarly, conscientiousness has been correlated with orderliness, reliability,

decisiveness, competence, and self-discipline.<sup>25</sup> The traits are clearly desirable in orthopaedic residents, and deficiencies in these areas can place resident education and patient care at risk. Short questionnaires have been developed and validated to quantify each of these personality characteristics.<sup>15,24,25</sup>

Although these traits seem desirable in applicants to orthopaedic surgery residency programs, very little is known about baseline levels of grit, self-control, and conscientiousness in this population. One method for assessing these qualities would be to administer the questionnaires to applicants during the interview or application process. However, if an applicant knows that a questionnaire will be used to determine their suitability as a potential resident, notable desirability bias is introduced. Applicants may knowingly or unknowingly inflate their responses to appear more favorable in the eyes of the programs to which they are applying. To overcome this potential limitation, objective measures of these traits that are less subject to bias are needed. Accordingly, the purposes of this multicenter study were to (1) quantify and characterize grit, self-control, and conscientiousness in orthopaedic surgery applicants and (2) correlate these scores with objective measures commonly obtained through the standard application process such as applicant demographics, USMLE scores, and AOA status. It is our hope that this work will allow program directors and educators to better objectively identify desirable personality traits in applicants and assign appropriate weight to the standard applications measures already in widespread use.

## Methods

After approval of the institutional review boards at all sites, the 17-item

Grit Scale, 10 item Self-Control Scale, and the 9-item Conscientiousness Scale were electronically administered to all students applying for orthopaedic surgery positions at one of the four participating study institutions (eg, Mayo Clinic, Hospital for Special Surgery, Rush University Medical Center, University of Cincinnati) during the 2017 National Resident Matching Program. These were administered after applications were submitted but before match day. Each of these scales has been previously published and validated.<sup>15,24,25</sup> Each is based on a five-point scale in which five represents the highest possible score (eg, most grit, self-control, conscientiousness) and one represents the lowest possible score (eg, minimal grit, self-control, conscientiousness). Only questionnaires that were answered in their entirety were included in the analysis. All scales were administered and analyzed in a completely anonymous and deidentified fashion. Applicants were made aware that the information was being collected anonymously and that their answers would have no bearing on their application or status at any of the participating institutions. Accordingly, they were encouraged to answer all questions in a truthful and accurate manner.

In addition to the previously validated scales, a number of personal and academic applicant demographics were assessed. Personal demographics included age, sex, current or previous military experience, previous participation in varsity collegiate athletics, desired future practice setting, desired future fellowship, and whether the applicant felt that the 80-hour work week restriction was reasonable and appropriate. Academic variables included USMLE Step 1 score, AOA status, additional graduate degrees, and the number of peer-reviewed publications in print.

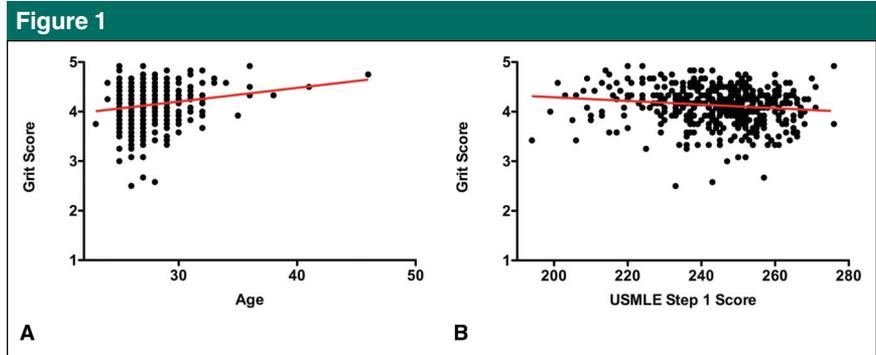
The 17-item Grit scale was used to calculate scores for overall grit and

the following three subscales: Consistency of Interest, Perseverance, and Ambition. Self-control and conscientiousness were calculated from their respective full scales. For each measure, the highest possible score was 5, and the lowest possible score was 1. Scores were then compared across the different demographic and academic variables studied.

Descriptive statistics are used to report basic measures such as number, mean ( $\pm$ SD), range, and median. Pairwise comparisons of continuous variables were performed using a two-tailed Student *t* test. These results are reported with their corresponding mean differences (MD), 95% confidence intervals (CIs), and *P* values. To compare the mean values of continuous variables across three or more groups, analysis of variance was performed. When analysis of variance demonstrated statistical significance, post hoc Tukey testing was performed to assess for pairwise differences. To understand the relationship of outcomes across continuous variables such as age and USMLE scores, linear regression analyses was performed. These results are reported with their corresponding *P* values. Only *P* < 0.05 were considered to represent statistical significance.

## Results

A total of 455 applicants completed the scales in their entirety, for an overall completion rate of 50.8% (455 of 895). Of these, 92 (20.2%) were women, and 363 (79.8%) were men. The mean age was  $27.3 \pm 2.4$  years, and the range was 23 to 46 years (median, 27 years). The average USMLE Step 1 score was  $244 \pm 13.8$  (range, 194 to 276). A total of 171 applicants (37.6%) participated in varsity athletics while in college, and 17 (3.7%) had previous or current military experience. A total of 167 applicants (40.5%) were members of



As age increased, a significant increase was noted in the grit score ( $P < 0.001$ ; adjusted  $R^2 = 0.03$ ) (A); however, as USMLE Step 1 Scores increased, grit score decreased ( $P = 0.004$ ; adjusted  $R^2 = 0.02$ ) (B). USMLE = United States Medical Licensing Examination

AOA, and 96 (21.1%) had obtained at least one graduate degree in addition to their medical degree. Three hundred eighty-six applicants (84.8%) agreed with the statement that the “current 80-hour work week restriction was appropriate and reasonable.” Regarding desired future practice type, 124 (27.3%) desired an academic practice, 135 (29.7%) wanted a private practice, 185 (41.7%) desired a hybrid between the two, and 11 (2.4%) wanted a hospital-employed position. The average number of peer-reviewed publications for this cohort was  $3.9 \pm 7.6$  (median, 2), but the range was broad (zero to 93).

Overall, the mean grit score was  $4.12 \pm 0.38$ , which places the applicant pool in the 70th percentile for grit compared with the general, adult population.<sup>15</sup> A statistically significant relationship was noted between age and grit, with older applicants possessing more grit than younger applicants (estimate, 0.028;  $P < 0.001$ ) (Figure 1, A). Grit increased by 0.14 points (ie, approximately 7 percentile points) for every 5-year increase in age. The opposite was seen for USMLE Step 1 scores as higher scores actually correlated with lower grit scores (estimate,  $-0.004$ ;  $P = 0.004$ ) (Figure 1, B). This correlated to a 0.07 point (approximately 3.5 percentile points) increase in grit

for every 20 point decrease in the board score. Age did not correlate with self-control ( $P = 0.067$ ) or conscientiousness ( $P = 0.706$ ); and the same was observed for USMLE scores ( $P = 0.332$  for self-control and  $P = 0.676$  for conscientiousness).

A detailed analysis of grit based on applicant demographics is provided in Table 1. Women demonstrated increased grit compared with men (4.20 versus 4.11; MD, 0.09; 95% CI, 0.01 to 0.18;  $P = 0.004$ ), and they had less variability in their grit scores (range, 3.33 to 4.83) compared with men (range, 2.50 to 4.92) (Figure 2, A). For the grit subscales, females had greater consistency of interest (3.90 versus 3.72;  $P = 0.003$ ) and conscientiousness (4.58 versus 4.48;  $P = 0.029$ ) than their male counterparts, but no differences were noted in perseverance of effort or ambition. Self-control was similar between the sexes (Table 2; Figure 2, A), but females scored higher in conscientiousness (4.58 versus 4.48; MD, 0.10; 95% CI, 0.01 to 0.20;  $P = 0.029$ ) (Table 3; Figure 2, A).

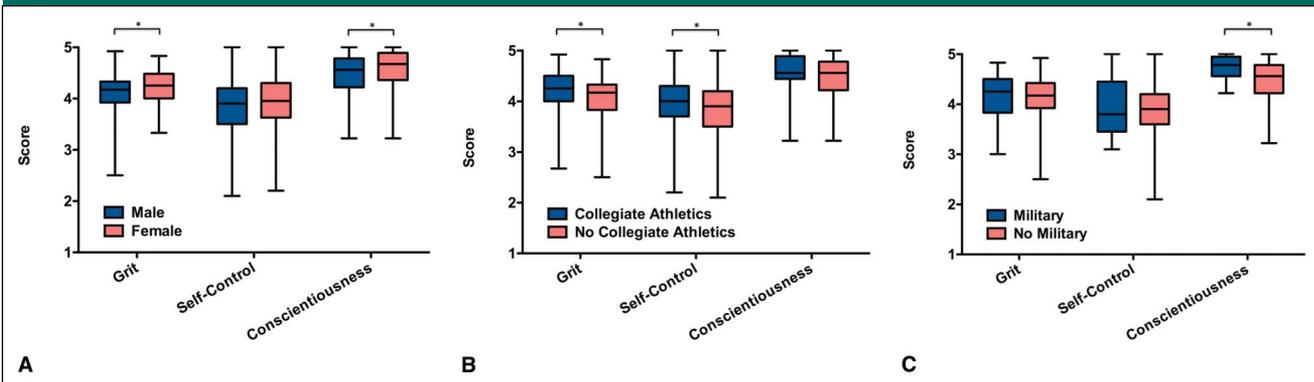
Former collegiate varsity athletes were grittier than nonathletes (4.21 versus 4.08; MD, 0.13; 95% CI, 0.06 to 0.20;  $P < 0.001$ ) (Table 1; Figure 2, B). In addition, they demonstrated increased consistency of interest (3.8 versus 3.70;  $P = 0.007$ ), perseverance

**Table 1**  
**Comparison of Grit Scores Based on Different Applicant Characteristics**

Variable	N	%	Mean	SD	Range	Median	MD	95% CI	P Value
Overall	455	100.0	4.12	±0.38	2.50-4.92	4.17	—	—	—
Sex									
Female	92	20.2	4.20	±0.35	3.33-4.83	4.25	0.09	0.01 to 0.18	<b><i>0.044</i></b>
Male	363	79.8	4.11	±0.39	2.50-4.92	4.17	—	—	—
Varsity college sports									<b><i>&lt;0.001</i></b>
Yes	171	37.6	4.21	±0.39	2.67-4.92	4.25	0.13	0.06 to 0.20	—
No	284	62.4	4.08	±0.37	2.50-4.83	4.17	—	—	—
AOA status									0.166
Yes	167	40.5	4.09	±0.39	2.58-4.92	4.17	0.05	-0.02 to 0.13	—
No	245	59.5	4.14	±0.38	2.50-4.92	4.17	—	—	—
Military experience									0.957
Yes	17	3.7	4.12	±0.50	3.00-4.83	4.25	0.01	-0.17 to 0.19	—
No	438	96.3	4.13	±0.37	2.50-4.92	4.17	—	—	—
No. of publications									0.732
0	103	22.6	4.10	±0.36	3.08-4.92	4.17	—	—	—
1-3	225	49.5	4.13	±0.38	2.67-4.92	4.17	—	—	—
3 or more	127	27.9	4.14	±0.40	2.50-4.83	4.17	—	—	—

AOA = Alpha Omega Alpha, CI = confidence interval, MD = mean difference  
 Bold and italicized P values indicate statistical significance ( $P < 0.05$ ).

**Figure 2**



Comparison of grit, self-control, and conscientiousness between females and males (A), college athletes and nonathletes (B), and applicants with and without military experience (C). \*Statistically significant differences were  $P < 0.05$ . For each plot, the horizontal line represents the mean, the box represents the 25th to 75th percentiles, and the bars represent minimum and maximum scores.

of effort (4.56 versus 4.46;  $P = 0.006$ ), and self-control (3.97 versus 3.85;  $P = 0.019$ ) (Table 2).

Those desiring an academic practice had more consistency of interest (3.88) than applicants desiring hybrid (3.71;  $P = 0.029$ ) or private practice settings (3.71;  $P = 0.025$ ).

They were also more ambitious (4.44 versus 4.29;  $P = 0.019$ ) and had greater self-control (4.00 versus 3.81;  $P = 0.006$ ) than those wanting to enter private practice.

Finally, military status did not correlate with grit (Table 1; Figure 2, C); however, applicants with military

experience had greater ambition (4.59 versus 4.37;  $P = 0.033$ ) and were more conscientious (4.73 versus 4.49;  $P = 0.001$ ) (Table 3).

No significant correlations were found for any of the scales (eg, grit, self-control, conscientiousness) or subscales (eg, consistency of interest,

**Table 2****Comparison of Self-control Scores Based on Different Applicant Characteristics**

Variable	N	%	Mean	SD	Range	Median	MD	95% CI	<i>P</i> Value
Overall	455	100.0	3.9	±0.52	2.1-5.0	3.90	—	—	—
Sex									<b>0.529</b>
Female	92	20.2	3.93	±0.58	2.2-5.0	3.95	0.04	-0.08 to 0.16	—
Male	363	79.8	3.89	±0.51	2.1-5.0	3.90	—	—	—
Varsity college sports									<b>0.019</b>
Yes	171	37.6	3.97	±0.52	2.2-5.0	4.00	0.12	0.02 to 0.22	—
No	284	62.4	3.85	±0.52	2.1-5.0	3.90	—	—	—
AOA status									0.157
Yes	167	40.5	3.93	±0.50	2.2-5.0	4.00	0.07	-0.03 to 0.17	—
No	245	59.5	3.86	±0.53	2.1-5.0	3.90	—	—	—
Military experience									0.757
Yes	17	3.7	3.93	±0.59	3.1-5.0	3.80	0.04	-0.21 to 0.29	—
No	438	96.3	3.89	±0.52	2.1-5.0	3.90	—	—	—
No. of publications									0.602
0	103	22.6	3.90	±0.51	2.2-4.9	3.90	—	—	—
1-3	225	49.5	3.87	±0.53	2.2-5.0	3.90	—	—	—
3 or more	127	27.9	3.93	±0.51	2.1-5.0	4.00	—	—	—

AOA = Alpha Omega Alpha, CI = confidence interval, MD = mean difference  
 Bold and italicized *P* values indicate statistical significance ( $P < 0.05$ ).

**Table 3****Comparison of Conscientiousness Scores Based on Different Applicant Attributes**

Variable	N	%	Mean	SD	Range	Median	MD	95% CI	<i>P</i> Value
Overall	455	100.0	4.50	±0.44	1.1-5.0	4.56	—	—	—
Sex									<b>0.029</b>
Female	92	20.2	4.58	±0.36	3.2-5.0	4.67	0.10	0.01 to 0.20	—
Male	363	79.8	4.48	±0.46	1.1-5.0	4.56	—	—	—
Varsity college sports									0.222
Yes	171	37.6	4.54	±0.51	1.1-5.0	4.56	0.06	-0.02 to 0.14	—
No	284	62.4	4.48	±0.40	3.2-5.0	4.56	—	—	—
AOA status									0.754
Yes	167	40.5	4.51	±0.46	1.1-5.0	4.56	0.01	-0.08 to 0.10	—
No	245	59.5	4.50	±0.43	1.2-5.0	4.56	—	—	—
Military experience									<b>0.001</b>
Yes	17	3.7	4.73	±0.24	4.2-5.0	4.78	0.24	0.24 to 0.46	—
No	438	96.3	4.49	±0.45	1.1-5.0	4.56	—	—	—
No. of publications									0.540
0	103	22.6	4.53	±0.39	3.2-5.0	4.56	—	—	—
1-3	225	49.5	4.51	±0.43	1.1-5.0	4.56	—	—	—
3 or more	127	27.9	4.47	±0.50	1.2-5.0	4.56	—	—	—

AOA = Alpha Omega Alpha, CI = confidence interval, MD = mean difference  
 Bold and italicized *P* values indicate statistical significance ( $P < 0.05$ ).

perseverance of effort, ambition) with the following variables: additional graduate degrees, AOA status, number of publications, or agreement/disagreement with the 80-hour workweek restriction.

## Discussion

Although a number of objective measures exist that programs can use to assess the academic and test-taking potential of orthopaedic applicants, much less is known about critical, noncognitive domains such as of grit, self-control, and conscientiousness. Each of these qualities is desirable in orthopaedic residents, but reliable predictors of these traits have not yet been identified. In this work, applicants to orthopaedic surgery residency programs were found to have a mean grit score of 4.12, which would place them in the 70th percentile of the general population. The factors that were most predictive of high levels of grit were increasing age, lower board scores, female sex, and a history of participation in collegiate athletics. Although current or former military experience was not associated with increased grit, it did correlate with higher levels of conscientiousness and ambition.

One of the more notable findings of this work was the relationship of grit to age (ie, reciprocal) and USMLE Step 1 scores (ie, inverse). Most applicants to orthopaedic programs were aged 25 to 29 years, and their board scores ranged from 230 to 258. Accordingly, applicants older than 30 years or those with board scores under 230, tend to be outliers from the majority because they are outside the standard deviation. Their willingness to pursue the same goal as more traditional applicants may be a direct reflection of their higher levels of grit. This finding may be an indicator that these outlying applicants may possess a growth mindset, which

is a term used to describe learners who “desire to learn and develop their abilities, pursue challenges, value effort, and are resilient to setbacks.”<sup>26</sup> Clearly, possession of a growth mindset and high levels of grit are desirable characteristics in orthopaedic surgery residents; however, these are certainly not the only factors to be considered. This is particularly true for applicants with decidedly low USMLE scores. Even if they have higher levels of grit, a number of studies have demonstrated that low USMLE scores are predictive of poor performance on the Orthopaedic In-Training Examination and higher failure rates for the American Board of Orthopaedic Surgeons Part I Board Examination.<sup>11,27,28</sup>

When applicants were compared based on sex, females outscored males in three of the six scales/subscales tested. These included grit, consistency of interest, and conscientiousness. Although the difference in grit between the sexes was small at 0.1 points, this represents a change of 5 percentile points compared with the general public (ie, 75th percentile for females and 70th percentile for males). It is also worth noting that the range of grit was tighter for females (Figure 2, A). Ultimately, 18% (67 of 363) of male applicants were below the 50th percentile for grit (compared with the general population) versus 12% (11 of 92) of females who fell below that mark. The increased grit observed in female applicants may be a key influence in their decision to enter into a field that has historically been comprised a male majority.<sup>29</sup>

The single variable that was predictive of increased scores across the most scales/subscales was participation in collegiate varsity athletics (ie, markedly increased scores in four of the six scales/subscales). Those with an athletic background demonstrated greater grit, consistency of interest, perseverance of effort, and self-control compared with all other applicants.

This relationship is one that has long been suspected anecdotally; however, it has never been quantified in this population of applicants. Regardless, it is a criterion that is commonly used in the evaluation and ranking of applicants,<sup>3,8,9,30,31</sup> and the current study supports this practice. On a similar note, applicants with military experience were more ambitious and conscientious than those without, and this was the greatest MD (0.24) of any comparison in the study. These qualities in athletes and military personnel are intuitive because these processes generally require discipline, strong interpersonal skills, a mentality of teamwork, and sustained effort for long-term goals.

There are a number of limitations to this work that merit discussion. Although the completion rate of 50.8% is higher than many similar cross-sectional studies, there is a potential for selection bias among the applicants who were willing and able to complete the assessment in its entirety. This may have potential to artificially inflate the mean scores of the outcomes measures. In addition, this work is limited in that it does not follow these applicants longitudinally to see which ultimately were successfully able to match. Similarly, it does not measure future performance in residency or beyond. Instead, this work provides predictors for important noncognitive variables at the time of application. Finally, it is important to point out that although many variables (eg, AOA status, number of publications, additional graduate degrees) did not correlate with the desired attributes, these factors can still have an important role in the selection process. An area of further exploration may reside in publication status of the applicant, considering how broad the range was within this study. Future work can hone in on whether grittier applicants trend toward more orthopaedic publications while in medical school, rather than those that have

published in other fields or during their undergraduate years.

## Conclusions

Ultimately, a number of objective characteristics and demographics were identified as predictors of grit, self-control, and conscientiousness among a large cohort of applicants to US orthopaedic surgery residency programs. The mean grit score of all respondents placed them in the 70th percentile of all adults, and even higher levels of grit were observed in females and collegiate athletes, older applicants, and those with lower USMLE Step 1 scores. Former participation in varsity collegiate sports was correlated with higher scores in four of the six scales/subscales assessed. Females outscored males in three of the six categories, and no significant differences were noted for the other three categories based on sex. Other factors that resulted in higher scores on these noncognitive domains included previous or current military experience and a desire to eventually practice orthopaedics in an academic setting. These data may help program directors and selection committee identify applicants with these desirable characteristics without having to administer additional tests or surveys that are subject to desirability bias.

## References

*Evidence-based Medicine:* Levels of evidence are described in the table of contents. In this article, references 2, 6, 7, 13, 14, 16, and 27 are level III studies. References 1, 3, 5, 8, 10-12, 17-24, and 28-31 are level IV studies. References 9 and 26 are level V reports or expert opinions.

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