

CLINICAL REVIEW

Managing the care of adults with Down's syndrome

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Down's syndrome results from increased genetic material on all or a portion of chromosome 21 and is characterized by intellectual disability and risk for comorbidities involving multiple organ systems.^{1,3} The survival of people with Down's syndrome has improved dramatically in the past few decades; the median age at death is now the mid-50s compared with less than 10 years of age in the 1970s.^{1,4-10} The aim of this clinical review is to assist healthcare professionals in caring for the growing population of adults with Down's syndrome, highlighting areas for increased vigilance as this population ages and develops comorbidities.

How common is Down's syndrome?

Down's syndrome affects approximately 1 per 1000 live births worldwide,¹¹ with increased incidence associated with advanced maternal age.³ With the introduction of commercially available first trimester fetal DNA testing in 2011,¹² the proportion of prenatal diagnoses of Down's syndrome in the United Kingdom has increased from 54% (2008) to 66% (2012) for women younger than 35 years but has remained relatively stable at 71% for women older than 35 years.¹³ Pregnancy termination rates after prenatal diagnosis of Down's syndrome vary by country (67% in the United States, 90% in the United Kingdom) but seem to be unaffected by the new fetal DNA diagnostic testing.^{13,14}

Nevertheless, the prevalence of Down's syndrome continues to increase worldwide, with dramatic gains in life expectancy in the past few decades.^{1,4,6,7} As such, care for affected adults is relatively new territory with little evidence to guide providers. To date, few clinical trials have involved adults with Down's syndrome. Unless otherwise noted, the information contained in this review is collected from international literature resulting from observational studies and expert consensus.

How long do people with Down's syndrome live?

The survival of people with Down's syndrome has dramatically increased in the past few decades, largely as a result of improved surgical repair of congenital heart defects.^{1,4,6-8} Until the 1970s, the median age at death for children with Down's syndrome

was less than 10 years.^{1,4,5} Now, 80% of affected individuals survive into adolescence,¹⁵ with a median age at death in their mid-50s.⁶⁻¹⁰

The leading causes of death in adults with Down's syndrome are diseases of the respiratory and circulatory systems. The percentage of adults who die of cardiac causes (including consequences of congenital heart disease) is 25-40%, with an additional 20-40% of deaths resulting from respiratory infections.^{8,9,16,17} The development of dementia becomes considerable after age 40, contributing to nearly one third of deaths.⁸ Aside from childhood leukemia, the incidence of neoplasms—hematologic or solid tumor—is low in all age groups with Down's syndrome.^{8,17} The risk of cardiac atherosclerosis remains lower than in the general population without Down's syndrome but increases to 13% in adults aged 50 or older.⁸

What are the most common comorbid conditions in Down's syndrome?

The table^{||} details our recommendations for evaluation of comorbid conditions and their frequency.

Endocrinology

Hypothyroidism is present in 15-37% of people of all ages with Down's syndrome.^{18,26,44,64} It presents with symptoms such as fatigue, weight gain, decreased interest in activities, or a decline in skills.^{2,27,81} Hyperthyroidism is slightly more common in people with Down's syndrome (0.65%) than in the general population, presenting with weight loss, heat intolerance, and irritability.⁶⁵ Currently accepted guidelines advocate annual thyroid function tests.^{2,35}

Obesity is widespread in people with Down's syndrome,²⁶ likely due to lower activity levels⁸² and a lower metabolic rate,^{83,84} making exercise and energy restriction critical in maintaining a healthy weight. Although exercise does improve muscle strength and balance in this population, significant weight loss requires programs combining interventions in exercise, nutrition, and behavior.⁷⁰ A comprehensive behavioral management program involving the patient's family in conjunction with

Summary points

- People with Down's syndrome have experienced a dramatic increase in life expectancy, which is now in their mid-50s
- The approach to primary care for adults with Down's syndrome is similar to that for the general adult population, with the addition of screening for conditions specific to Down's syndrome
- Practitioners must be vigilant for conditions that are more common in Down's syndrome than in the general population, such as hypothyroidism, obstructive sleep apnea, and osteoporosis
- Adults with Down's syndrome have a lower risk of hypertension, coronary artery disease, and solid tumors than the general population
- People with Down's syndrome have an increased risk of Alzheimer's dementia, but not all adults experience this; the onset of dementia is not typically seen before age 40. By age 60, 40-77% of adults will have Alzheimer's dementia
- Respiratory infection is the leading cause of death in adults with Down's syndrome

Sources and selection criteria

We based this narrative review on articles found by searching PubMed and the Cochrane Database of Systematic Reviews. We then applied snowball techniques to sources for the articles identified from both databases. Search terms first included "Down syndrome", "preventive health care", "epidemiology", and "adults with Down syndrome". We then searched specifically for articles dealing with comorbidities identified within that search. To date, few randomized controlled trials have involved adults with Down's syndrome, and many studies that do exist used small sample sizes. We referenced many of these studies to ensure that our review was thorough and accurate. The information contained in this review results primarily from literature arising from observational studies and expert consensus, unless noted otherwise.

calorie limitations has been shown to be successful for weight loss in the Down's syndrome population.⁷¹

Down's syndrome is an independent risk factor for osteoporosis.⁷⁷⁻⁸⁵ Incidence of fracture is reported to be as high as 55% (long bones) or 30% (vertebral bodies) in adults with Down's syndrome over 50 years old.⁴¹⁻⁷⁸ To prevent such fractures, we recommend screening adults for osteoporosis in their 40s based on these observational studies.

Cardiology

Congenital heart disease is present in 40-50% of people with Down's syndrome,²⁻¹⁸⁻¹⁹ with up to 60% attributable to some type of atrioventricular canal defect.⁸⁶⁻⁸⁷ Common additional congenital heart disease pathology in this population includes atrial septal defect, ventricular septal defect, patent ductus arteriosus, tetralogy of fallot, and double outlet right ventricle.⁸⁷ Using routine prenatal ultrasound screening, prenatal diagnosis rates for serious congenital heart disease varies from 15-75% within the medical literature, with significantly improved detection resulting from consistent documentation of both the four chamber view of the heart and the fetal cardiac outflow tracts.⁸⁸ In the past, life expectancy was noticeably reduced due to heart defects and was the primary reason for early death in children with Down's syndrome. Now, these lesions are routinely surgically corrected.

Providers must be alert for the development of acquired valve disease, specifically mitral valve prolapse and aortic regurgitation.²⁰⁻²² Mitral valve prolapse can present in up to 45% of adults with Down's syndrome, which is often associated with mitral regurgitation.⁸⁷ In many of these cases a murmur is not detectable, so any signs of heart failure should be evaluated with an echocardiogram, such as dyspnea, orthopnea, raised jugular venous pressure, pulmonary rales, lower extremity edema, increased brain natriuretic peptide levels, or radiologic evidence of pulmonary edema.⁸⁹

Current expert opinion includes obtaining an echocardiogram for those who did not have one in childhood and a new echocardiogram for patients presenting with a new murmur or any clinical signs of heart failure.²⁻⁸⁷ Electrocardiograms should be obtained for any concerns of arrhythmia.⁹⁰

Gastroenterology

Gastroesophageal reflux is common in people with Down's syndrome, as is dysphagia. Both can present with weight loss,

decline in skills, or behavioral changes. The prevalence of gastroesophageal reflux is not well documented in the medical literature for children or adults with Down's syndrome, likely due to the fact that it is often treated empirically. Twenty five per cent of adults with Down's syndrome have major problems with swallowing,⁹¹ and dysphagia accompanies the aging process in this condition.⁹² In an observational study of adults with Down's syndrome without known swallowing difficulties, more than 50% showed risks for aspiration.⁹³ One should assess for swallowing difficulties in the presence of signs of aspiration, such as coughing, sighing, burping, or throat clearing during mealtimes.⁹³ Evaluation consists of a modified barium swallow study in conjunction with a speech pathology consultation.⁹⁴ Interventions for aspiration can range from dietary restrictions to avoidance of easily aspirated foods, as well as guidance during meals to normalize eating rate.⁹³

Celiac disease can develop throughout the lifespan of people with Down's syndrome, with an overall prevalence of 7-17%.²⁸ The condition can be asymptomatic⁹⁵ or can present with non-specific symptoms such as changes in behavior or mood, as well as weight loss and diarrhea.²⁸ Current recommendations suggest screening for symptomatic celiac disease in both children and adults.²⁻³⁶⁻³⁷ The only known effective treatment is a strict gluten-free diet.⁹⁶ Though a celiac diet is restrictive, it is generally well tolerated in adults with Down's syndrome.

Hematology-oncology

Though leukemia and transient myeloproliferative disorder are more common in children with Down's syndrome,⁶³ new presentations decrease with age; more than 90% of cases occur before age 20.⁹⁷ A Danish study of more than 2800 people with Down's syndrome found no cases of leukemia after age 29.⁹⁸ It is notable that childhood leukemias in people with Down's syndrome are unusually sensitive to chemotherapy, and outcomes can be excellent.⁶³⁻⁹⁹

People with Down's syndrome have a high frequency of leukopenia, idiopathic macrocytosis, and mild polycythemia, often without underlying disease.¹⁰⁰ In one observational study, approximately two thirds of people with Down's syndrome had an increased mean corpuscular volume and one third had mild leukopenia.⁶² None the less, healthcare professionals must have a high index of suspicion for underlying disease, as adult onset leukemias do occur, albeit at a reduced rate. Providers should check a complete blood count in circumstances that would raise

suspicion for hematologic processes, such as easy bruising, petechiae, onset of lethargy, or change in feeding patterns.²

Pulmonology

Respiratory illnesses such as influenza, pneumonia, and aspiration pneumonia are common,^{101 102} accounting for 25% of hospital admissions among adults with Down's syndrome in an Israeli study.¹⁰³ Pneumonia is the leading cause of admission to hospital and the second leading cause of death in adults with Down's syndrome after congenital heart disease.^{8 17 103} The number of deaths attributable to pneumonia in Down's syndrome increases proportionately with age, as the rate of death from congenital heart disease decreases.⁸

Obstructive sleep apnea is among the most common comorbidities in adults with Down's syndrome.⁷²⁻⁷⁶ Many of the physical attributes associated with Down's syndrome predispose affected people to sleep apnea, such as mid-face hypoplasia, small upper airway, small jaw, and relative macroglossia.^{75 101 104} Obstructive sleep apnea can occur at any age and can present with changes in mood and behavior, a decline in skills, fatigue, and daytime sleepiness, as well as nocturnal gasping or choking episodes.^{105 106}

Behavioral and mental health

Concurrent mental health problems are common in people with Down's syndrome, with depression, anxiety, obsessive-compulsive tendencies, and behavioral issues making up most diagnoses.^{107 108} Mental illness can present with a decline in skills or urinary incontinence, which can be mislabeled as Alzheimer's dementia.¹⁰⁸ Depression can be triggered by a stressful life event, such as separation from a parent or a death in the family. As depression is often responsive to medical therapy in those with Down's syndrome,¹⁰⁹ differentiating it from dementia is vital. Discriminating depression from dementia can be difficult, as many symptoms overlap and depression can be an early sign of developing dementia. The more common presenting symptoms of depression in those with Down's syndrome include withdrawal, decreased appetite, and decrease in speech.¹¹⁰

Autism spectrum disorder is up to 10 times more common in children with Down's syndrome than the general population.^{107 111} Concurrent Down's syndrome and autism in adulthood can be extremely difficult to treat, often requiring a specialist who works with adults with special needs.¹⁰⁷ Medical therapies, behavioral management, maintenance of a stable environment, and reduction of stressors are all accepted forms of therapy.¹⁰⁷

Developmental regression (young adults with disintegrative syndrome) is a rare condition that occurs in adolescents with Down's syndrome, involving rapid, atypical loss of previously acquired skills in cognition, socialization, and activities of daily living, with an increase in maladaptive behaviors.^{112 113} Clinical experience suggests this seems to occur in relation to transitions, hormonal or menstrual changes, or major life events.¹¹² Given the rarity of this phenomenon, little evidence exists to recommend standard treatment modalities, and management may need to involve a specialist working with adults with special needs.¹¹² Evaluation should include all causes of loss of skills (box).

Neurology

Alzheimer's dementia is a clinical diagnosis with increased incidence associated with aging in adults with Down's syndrome (table).⁵³ Though autopsy specimens of adults with Down's

syndrome older than 35 years show neurofibrillary plaques and tangles, Alzheimer's dementia does not develop universally in this population.^{114 115} Few cases of true Alzheimer's dementia present before age 40.^{54 116}

Distinguishable differences exist between the presentations of Alzheimer's dementia in those with and without Down's syndrome. People with both dementia and Down's syndrome tend to develop sleep disturbance, apathy, gait changes, and personality changes.¹¹⁷ Seizures and incontinence are also highly associated with the diagnosis of dementia in people with Down's syndrome over age 40.¹¹⁸

The diagnosis of Alzheimer's dementia relies on the report of caregivers, which often focuses on behaviors that impact the caregivers themselves. This can lead to an overestimation of the diagnosis compared with direct assessment. Additionally, clinicians are predisposed to over-diagnose dementia in people with Down's syndrome, as the clinical diagnosis of dementia is difficult to make and the inevitability of dementia is assumed.¹¹⁷ Traditional tools, such as the mini-mental status examination, are unreliable and unusable in nearly half of adults with Down's syndrome.¹¹⁷ Despite multiple options, there is no evidence based consensus on the single best method for assessment of dementia in people with Down's syndrome.^{55 119 120} Two of these tools that are often used and generally accepted include the adaptive behavior dementia questionnaire¹²¹ or the Camdex-R assessment of cognitive functioning.¹¹⁷ An assessment for dementia must include medical and psychiatric investigations, as multiple conditions can mimic the decline of skills in Alzheimer's dementia.

At this time, the treatments available for adults with Down's syndrome and dementia are mainly supportive. While some providers will use traditional pharmacologic agents to slow the rate of decline, multiple Cochrane reviews of pharmaceutical treatment for dementia in adults with Down's syndrome do not support this treatment owing to lack of evidence.¹²²⁻¹²⁵ The largest trial of pharmaceutical intervention in adults with Down's syndrome and dementia used memantine, which showed no benefit and a trend toward worse behaviors in the treatment group.¹²² Consequently, current recommendations focus on interventions to minimize caregiver burden, including respite care and creating an environment in which the patient can maintain function.

Adult onset seizure disorder can occur as a precursor to the cognitive decline of Alzheimer's dementia and can further impair cognitive function if uncontrolled.^{111 126}

Problems in the cervical spine are common in adults and children. While atlantoaxial instability is the most common problem in children,²⁷ degenerative disease of the cervical spine is more prevalent in adults (64-70%), with an additional 36% demonstrating lower cervical spondylosis.^{28 50-52} Spinal imaging should be obtained to evaluate signs of spinal stenosis, such as hyperreflexia, clonus, and ataxia.²⁸

Are there any medical advantages in people with Down's syndrome?

Several conditions are less common in people with Down's syndrome than in the general population.

Hematology and oncology

Though the risk of leukemia is significantly increased in children with Down's syndrome, this risk normalizes after age 20,⁹⁷ with a cumulative risk of leukemia of 2.7% by age 30.¹²⁸ Adults with Down's syndrome are at lower risk for most solid tumors, such

Practical tips for the care of adults with Down's syndrome

- The differential diagnosis for a decline in skills includes:
 - depression
 - hypothyroidism
 - sleep apnea
 - hearing loss
 - vision loss
 - dementia
 - seizure disorder
 - developmental regression
- Optimal evaluation includes the involvement of specialists with expertise in these domains in people with developmental disabilities
- Sleep apnea can present with a decline in skills and new mood disorders without other typical symptoms of apnea
- Important causes of unexplained weight loss include celiac disease and gastroesophageal reflux or dyspepsia
- Skin problems are widespread in people with Down's syndrome, such as
 - xerosis
 - hyperkeratosis
 - folliculitis
 - acne
 - psoriasis
 - atopic dermatitis
- Skin problems should be managed with traditional medical therapy as used in the general population
- People with Down's syndrome generally do well with consistent schedules and can blossom in a setting of predictable routine

as cervical, breast, lung, and prostate cancers^{99 129}; however, they do seem to have a slight increased risk of ovarian and testicular germ cell tumors (standardized incidence ratios of 1.97 and 1.86, respectively).^{98 128 130}

Cardiology

While the risk of congenital heart disease is quite high, the incidence of coronary artery disease in adults with Down's syndrome is decreased compared with the general population.⁸ Autopsy studies show decreased plaque deposition in all arteries of adults with Down's syndrome compared with the general population.¹³¹

Adults with Down's syndrome have decreased risk of hypertension, with blood pressure measurements averaging approximately 10 points lower than their age matched peers.¹³²

What is the approach to social aspects of care?

People with Down's syndrome benefit greatly from consistency and routines in their schedule.¹³³ Once they have learnt a routine, they tend to have better skills for personal care, activities of daily living, and meal related activities than others with intellectual disabilities.¹³⁴ This need for consistency can, however, lead to difficulties with changes in routine or unexpected life events.

Extensive neuropsychiatric testing demonstrates that individuals with Down's syndrome have much stronger visual immediate memories than verbal immediate memories.^{111 135} As such, many persons with Down's syndrome are able to remember people and events with excellent accuracy. While this is often an advantage, it can pose a problem with traumatic events, causing longer term impact than in the general population.¹³⁶

Can people with Down's syndrome have children?

Women with Down's syndrome have decreased fertility compared with women in the general population but can

conceive and bear children.^{137 138} Approximately 50% of their children will have Down's syndrome; they also have increased risks for other congenital malformations.¹³⁹ It is therefore important to properly educate persons with Down's syndrome about their reproductive capacity and to consider contraceptive methods to prevent undesired pregnancy. This should occur as conversations between the primary care provider, patient, and caregiver, in addition to what occurs within formal education settings.¹⁴⁰ Men with Down's syndrome are typically considered sterile, but there have been case reports of children being fathered.¹⁴¹

How should providers approach primary care in adults with Down's syndrome?

The approach to primary care in adults with Down's syndrome is similar to that of the general adult population, with the addition of screening for conditions specific to Down's syndrome.¹⁴² The table provides a checklist of domains that need higher attention than may be intuitive to the general practitioner.

What specialists are usually involved in the care of adults with Down's syndrome?

While a primary care physician can manage most problems, a specialist can provide valuable care in several circumstances:

- Congenital heart disease (with or without repair)—a cardiologist with an understanding of congenital heart defects should be involved.^{20 90}
- Eye, dental, and hearing evaluations should be frequent and merit the involvement of optometrists or ophthalmologists, audiologists, and dentists.^{2 26 35}
- Early hearing loss and cerumen impaction—referral to an otolaryngologist may be needed.²
- Dementia—neurologists can be helpful in assessment and management; they should also be involved in the care of seizure disorder and gait disturbance.^{55 118}

- Atlantoaxial instability—neurosurgeons should evaluate all cases.²

Several complex problems may best be served by providers with expertise in Down's syndrome or adults with intellectual disabilities. In our clinical experience, we have found that comorbid psychiatric disease, such as obsessive-compulsive disorder or autism, can be challenging to manage and often merits the involvement of a psychiatrist or behavioral specialist with an interest in people with special needs.¹⁰⁷

Significant weight loss can result from behavioral problems, endocrine causes, or gastrointestinal causes (most commonly gastroesophageal reflux, celiac disease, hyperthyroidism, and diabetes). This may warrant evaluation by the appropriate specialists if a cause is not easily identified in primary care.^{2 28}

The most common causes for a decline in skills in adults with Down's syndrome younger than age 40 are psychiatric issues and difficulty overcoming a loss, such as the death of a family member or caregiver. After age 40, evaluation for Alzheimer's dementia should be included.²⁸

What ethical issues should be considered in the care of adults with Down's syndrome?

Although people with mild to moderate intellectual disabilities can be trained in self advocacy skills,¹⁴³ many people with Down's syndrome require assistance in making medical and legal decisions for their lives. This often results in establishing formal guardianship, lasting power of attorney (United Kingdom), or durable power of attorney (United States). However, given the spectrum of intellectual ability and disability present in people with Down's syndrome, patients, caregivers, and providers must weigh the delicate balance between preserving autonomy and medical capacity.

To demonstrate capacity, people should understand in simple language the purpose and nature of the proposed medical treatment, its benefits, risks, and alternatives, and the consequences of foregoing treatment. People must be able to retain this information long enough to make an effective decision that is free from pressure.¹⁴⁴

The UK Mental Capacity Act of 2005 requires that providers assume patients are competent to make decisions unless they are obviously unable to do so and that patients must be given a reasonable chance to demonstrate their capacity.¹⁴⁵ The treatment of adults without capacity must be both necessary and in their best interests.¹⁴⁵ As with the Adults with Incapacity Act 2000 (Scotland), proxy decision makers must ensure that all decisions confer benefits on the patient and are advocated to use substituted judgment (that is, "what would the patient want?") in such decisions.¹⁴⁶ Full guardianship, then, is intended for situations in which no other means are sufficient to safeguard or promote the best interest of adults without capacity.¹⁴⁶

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Details of initial visit and annual examination of adults with Down's syndrome

- Routine age and sex appropriate primary care^{2 26 35 40}
- Comprehensive review of medical and surgical history
Specific attention to patient's history of and evaluation for common conditions associated with Down's syndrome (see table)
- Current functional status
- Family history
At this time, expert consensus is that family history should dictate cardiac and cancer screenings (though rare, coronary artery disease and solid tumors do occur)
- Social history
Living environment
Consistency in routine and daily schedules
Anticipated changes to daily activities or caregivers
Educational history
Occupational history
Insurance status
Supplemental income
Tobacco use or exposure
Alcohol use or exposure
Drug use or exposure
Reproductive history and sexual activity
- Legal history
Guardianship, durable power of attorney, medical decision makers
- Current and previous providers
Names and specialties of previous primary care providers and specialists
- Allergy list and reactions
- Medication list

*Data are compiled from multiple sources

Directions for further research

Basic science researchers of Down's syndrome are currently working on several exciting domains:

Suppression of the extra copy of chromosome 21 within mouse models¹⁴⁷

Pharmacologic agents to improve overall cognition¹⁴⁸

Induction of human pluripotent stem cells derived from people with Down's syndrome to create cortical neurons to test new pharmacologic agents aimed at treating Alzheimer's dementia¹⁴⁹

Explorations regarding the pathophysiology behind the health benefits of Down's syndrome are also intriguing, including their decreased risks of cancer,^{99 129} coronary artery disease,⁹ and hypertension¹³²

To better study health outcomes in adults with Down's syndrome, more data are needed; leaders in this field are creating registries to better quantify the burden of comorbid conditions and to improve the quality of life for people with Down's syndrome^{150 151}

Additional educational resources

Resource for healthcare professionals

United Kingdom Down Syndrome Medical Interest Group (www.dsmig.org.uk)—A review for healthcare professionals of "best practice" medical care for people with Down's syndrome in the United Kingdom and Ireland

Resources for patients

National Down Syndrome Congress (www.ndscenter.org)—Resources, advocacy, and support for persons with Down's syndrome in the United States

National Down Syndrome Society (www.ndss.org)—Advocacy information for persons with Down's syndrome in the United States

Canadian Down Syndrome Society (www.cdss.ca)—Resources for the care and support of persons with Down's syndrome living in Canada

Down Syndrome Australia (www.downsyndrome.org.au/)—A comprehensive site of resources for persons with Down's syndrome living in Australia

Alzheimer's and Down Syndrome (http://alzheimers.gov/down_syndrome.html)—Resources regarding the diagnosis and treatment of Alzheimer's dementia in persons with Down's syndrome through the US Department of Health and Human Services

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Table

Table 1 | Suggestions for periodic screening of various health domains

Domain	Prevalence	Screening	
		Tests	Frequency*
Cardiac:			
Congenital heart disease ^{18 19}	40-50%	Per cardiologist	Per cardiologist
Acquired valve disease ²⁰⁻²⁵	8-46%	Echocardiography	Evaluation guided by symptoms
Celiac disease ^{2 26-34}	7-17%	IgA and IgG anti-gliadin antibodies; total IgA; IgA anti-tissue transglutaminase antibodies; endomysial antibody	Evaluation guided by symptoms
Cervical cancer ^{26 27 35-43}		Cervical smear test	Every 3-5 years as dictated by history and risk factors
Cervical spine ^{26 27 35 37 42 44-52}	Atlantoaxial instability, 15%; cervical spondylosis, 36%; degenerative disease of the cervical spine, 64-70%	Asymptomatic: flexion or extension radiography of cervical spine if indicated. Symptomatic (cervical pain, torticollis, hyperreflexia, ataxia, quadriparesis): check computed tomography or magnetic resonance image of cervical spine and involve neurosurgery	Confirm neutral position of cervical spine for all procedures involving anesthesia; evaluate neurologic function annually; evaluation is otherwise recommended based on symptoms and involvement in extracurricular activities
Dementia screening/behavioral changes ^{24 26 35 37 38 44 53-56}	Alzheimer's disease: age 40-49, 10-22%; age 50-59, 20-25%; age ≥60, 40-77%	Adaptive behavior dementia questionnaire and Camdex-R	Screen yearly, starting by age 40
Dental care ^{26 27 35 37 38 42 46 57}	Dental problems, 94%	Per dentist	Every 6 months
Hearing ^{2 23 24 26 27 35 37 38 40 42 44 46 56 58-61}	50-90%, or higher hearing loss	Auditory testing	Every 2 years
Hematology ^{2 27 37-40 44 46 56 57 59 62 63}		Complete blood count	Monitor as needed for anemia, myelodysplastic syndrome, leukemia, especially with symptoms of easy bruising, petechiae, onset of lethargy, or change in feeding patterns.
Hypothyroidism ^{2 18 23 24 26 27 35 37 38 40 42 46 56 64}	15-37%	Thyroid stimulating hormone, free thyroxine	Annually
Hyperthyroidism ⁶⁵	0.65%	Thyroid stimulating hormone, free thyroxine	Annually
Immunizations (per adult guidelines) ⁶⁶		Influenza; tetanus; pneumonia	Annually; every 10 years, with 1 containing pertussis in adulthood; one dose at age ≥65, 1 or 2 doses at age <64 based on risk factors, with revaccination again at age ≥65
Mental health ^{24 26 27 35 38 41 42 44-46 56 57 67 68}	25-30%	Assess for behavioral changes and loss of function	Every visit
Obesity ^{23 26 27 35 37 38 42 44 56 57 69-71}	89-95%	Body mass index	Every visit
Obstructive sleep apnea ^{26 44 72-76}	30% to nearly 100%	Polysomnography, overnight pulse oximetry may be useful	Guided by symptoms
Osteoporosis ^{26 77-80}	25-50% (men and women)	Bone densometry	Start screening women no later than onset of menopause or age 50, whichever comes first; screen men and women earlier based on risk factors, such as poor mobility, anti-psychotic medications, anti-seizure medications, poor nutritional status, non-weight bearing status
Vision ^{18 26 44}	Vision problems, 60-70%; cataracts, 15-22%; keratoconus, 5-15%	Ophthalmology examination	Every 1 or 2 years

*Cumulative results of studies cited led to suggested screening frequencies for each domain.