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United States Government Accountability Office
Washington, DC 20548

April 4, 2008

The Honorable Edward M. Kennedy
Chairman
Committee on Health, Education, Labor, and Pensions
United States Senate

Dear Mr. Chairman:

Subject: *Temporomandibular Joint and Muscle Disorders: NIH Supports a Wide Range of Research*

Temporomandibular joint and muscle disorders (TMJD) include a heterogeneous group of disorders with overlapping—but not identical—signs and symptoms.¹ Symptoms of TMJDs vary, but typically include pain in the jaw joint and surrounding muscles. Other symptoms may include limited or no movement of the jaw joint, clicking or grating in the jaw joint when opening or closing the mouth, headaches, and shoulder or back pain. Most people with TMJDs have relatively mild forms of these disorders with symptoms that diminish without treatment.² However, a small number of individuals develop significant, long-term problems, including persistent and debilitating pain and loss of jaw function.³ Although some TMJDs are due to a specific known cause, such as jaw injury or arthritis, the causes of many TMJDs are unknown. While the level of understanding about these conditions has evolved with scientific advancements, diagnosis and treatment are difficult because the exact causes and patterns of symptoms remain unclear.

The National Institutes of Health (NIH), an agency within the Department of Health and Human Services (HHS), funds research on the causes of, treatments for, and other aspects of TMJDs. The NIH is organized into 27 institutes and centers and the Office of the Director, each with its own mission and functions. Through these institutes and centers, NIH supports both extramural research—conducted at external research institutions by scientists who are awarded funds to support their work—and intramural research conducted by its own

¹In this report, we use the acronym TMJDs to be consistent with the terminology preferred for this set of conditions by the National Institutes of Health (NIH). Other common acronyms include TMJ and TMD.

²Although NIH previously reported that TMJDs may affect as many as 10 million Americans, this estimate is based on papers presented at the Technology Assessment Conference on TMJDs in 1996. NIH officials told us that additional epidemiological research is needed to validate the number of Americans affected by TMJDs.

³Artificial temporomandibular joint implants have been used to replace the jaw joint in an effort to decrease pain and increase jaw function for some individuals in this latter group. Experts recommend that conservative treatments be used to relieve symptoms before irreversible treatments—such as implants—are used. Conservative treatments can include taking pain medications, using a splint or bite guard, applying ice packs, or eating soft food. See GAO, *Medical Devices: FDA's Approval of Four Temporomandibular Joint Implants*, GAO-07-996 (Washington, D.C.: Sept. 17, 2007).

scientists. In 1996, NIH sponsored a Technology Assessment Conference that included a panel of experts from a variety of fields, including clinical dentistry, medicine, surgery, immunology, behavioral and social sciences, and pain management.⁴ The panel addressed, among other things, the effective management and treatment of patients with TMJDs and the most productive directions for future research, including both applied and basic research.⁵ The panel concluded there was a clear need for applied research on a number of issues, including the prevalence of TMJD symptoms, predisposing and precipitating conditions, diagnostic methods, and treatment outcomes. It also concluded that there was a need for basic research in areas such as pain and biomechanics.⁶

Noting that TMJDs continue to pose complex health problems for the American public, you expressed interest in the progress that has been made in acting on the panel's conclusions. We are reporting on (1) TMJD-related research activities that NIH supported from fiscal year 2002 through fiscal year 2006, and (2) NIH's plans to support future research on TMJDs.

To identify TMJD-related research activities supported by NIH from fiscal years 2002 through 2006, we examined data provided to us by NIH that listed projects on, or related to, TMJDs that it funded during that time period.⁷ Because we learned that some NIH institutes and centers did not begin reporting TMJD-related projects until after fiscal year 2002 and that institutes and centers differed in their methods for determining whether projects were TMJD-related, we validated the list of projects NIH provided. We took several steps to do so. For each listed project, we reviewed an abstract or other documentation, such as a progress report, to confirm that it was TMJD-related. We also developed a list of potentially relevant projects through a keyword search of HHS's publicly available Computer Retrieval of Information on Scientific Projects (CRISP) database. We then compared NIH's list to those we identified through our CRISP search. When we identified discrepancies between the lists, we obtained clarifying information from NIH officials and reached agreement about whether to include or exclude specific projects. Based on these analyses and discussions, we determined that our final list of TMJD-related projects supported by NIH from fiscal years 2002 through 2006 was sufficiently reliable and valid for our purposes.

To identify NIH's plans to support future research on TMJDs, we reviewed targeted funding announcements—public announcements that describe specific areas of research that NIH is interested in funding—released from December 2005 through December 2007. We identified relevant funding announcements by conducting a keyword search of NIH's online Guide for Grants and Contracts that is available through NIH's Office of Extramural Research Web

⁴*Management of Temporomandibular Disorders: National Institutes of Health Technology Assessment Conference Statement April 29–May 1, 1996* (Bethesda, Md.: U.S. Department of Health and Human Services, National Institutes of Health, 1996).

⁵Applied research involves systematic study to gain the knowledge or understanding necessary to determine the means by which a recognized and specific need may be met. Applied research that addresses clinical issues (such as the diagnosis or treatment of disease) is often referred to as clinical research. Basic research involves systematic study directed toward fuller knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards processes or products in mind. Basic research may, however, include activities with the potential for broad applications.

⁶Biomechanics refer to the mechanical bases of biological, especially muscular, activity and the study of the principles and relations involved. Research on the biomechanics of TMJDs could include, for example, research on jaw movement or jaw muscle development.

⁷When we did our work, fiscal year 2006 was the most recent year for which NIH could provide full information about the TMJD-related projects it funded.

site.⁸ We discussed NIH's plans to support future research on TMJDs with agency officials. In addition, we interviewed representatives of three TMJD advocacy groups to help us understand their perspectives on research related to TMJDs. These three advocacy groups were the American Alliance of TMD Organizations, the Jaw Joints & Allied Musculo-Skeletal Disorders Foundation, and the TMJ Association. Enclosure I contains additional information about our scope and methodology.

We conducted this performance audit from February 2007 through March 2008 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Results in Brief

NIH supported a wide range of TMJD-related research from fiscal year 2002 through fiscal year 2006. We identified 170 TMJD-related projects supported by NIH during this time period. These projects varied in the types of research activities involved, the institutes and centers that supported them, and the questions the research was designed to investigate. Specifically, NIH supported a variety of different research activities through, for example, grants to support discrete projects performed by investigators in their specific area of interest and grants to support organized efforts of several investigators conducting related research projects. Most of the projects we identified were supported by NIH's National Institute of Dental and Craniofacial Research (NIDCR); nine other institutes and centers and the Office of the Director also supported TMJD-related projects. The research supported by NIH during this time period addressed a wide range of questions related to TMJDs. For example, research addressed questions about the prevalence of TMJD signs and symptoms, predisposing and precipitating conditions, gender differences in TMJDs, pain, and biomechanics.

NIH officials told us that the agency plans to support future research on TMJDs by continuing to fund research it finds meritorious, including research applications submitted in response to targeted funding announcements. Several targeted funding announcements issued from December 2005 through December 2007 signaled NIH's interest in supporting research in areas involving TMJDs. These announcements either focused directly on TMJDs or addressed research areas, such as pain, that could include TMJDs. Specifically, NIH signaled interest in receiving applications in one area of research that directly focused on TMJDs—the co-occurrence of TMJDs with other chronic conditions, such as chronic fatigue syndrome. During the same 2-year time period, NIH signaled interest in receiving applications addressing 15 other areas of research that identified TMJDs as a possible focus, but did not require investigators to include TMJDs as a focus of their research proposal. NIH officials reported that they may issue additional targeted funding announcements to encourage future research on specific aspects of TMJDs.

HHS provided technical comments on a draft of this report, which we incorporated as appropriate.

⁸See <http://grants.nih.gov/grants/guide/index.html> (accessed on Jan. 16, 2008).

Background

The goals of NIH-supported research are to advance the understanding of biological systems, improve the control of disease, and enhance health. NIH has recognized the need for research on TMJDs to develop a better understanding of the onset and natural course of these disorders and to develop new diagnostic and treatment approaches. NIH reported that its institutes and centers obligated about \$90.6 million for TMJD-related extramural and intramural research in fiscal years 2002 through 2006.⁹

Temporomandibular Joint and Muscle Disorders

Although much remains unknown about TMJDs, the level of understanding about them has evolved over time. For example, since the 1996 Technology Assessment Conference, it has become apparent that individuals with TMJDs often experience other chronic and painful disorders, such as chronic fatigue syndrome, fibromyalgia, and irritable bowel syndrome.¹⁰ In addition, subsequent research has found that women in their childbearing years are more likely than men or than younger or older women to seek care for TMJDs, suggesting a possible role of female sex hormones in TMJDs.¹¹

NIH's Structure and Processes for Supporting Research

NIH institutes and centers accomplish their mission chiefly by funding extramural research. NIH states that it seeks to fund high-caliber, unique, and investigator-initiated research that is relevant to public health needs. NIH funds research primarily by providing support for investigator-initiated applications that are submitted independently or in response to targeted funding announcements, with funding decisions made according to NIH priority areas, including TMJDs. Approximately 84 percent of NIH's budget—a total of about \$29 billion in fiscal year 2007—supports extramural research. This extramural research is supported

⁹NIH's reported obligations are based on information provided by its institutes and centers. These institutes and centers currently use different procedures to determine whether a project is TMJD-related. The institutes and centers also estimate how much of the total obligation for the project to designate as TMJD-related based on scientific judgments about the project. These estimated obligations do not necessarily represent the exact obligations, nor do they necessarily represent actual spending or costs. For example, reported obligations may be greater than actual spending on TMJD-related research if institutes or centers designated a high proportion of the total amount obligated to a project as TMJD-related and only a small proportion of the project's actual costs were TMJD-related. Reported obligations may be lower than actual spending if institutes or centers did not identify all TMJD-related projects, or did not include projects of peripheral relevance to TMJDs. NIH officials stated that the process of determining which projects are sufficiently related to TMJDs and which are not is complex and involves scientific judgment. For example, much of NIH's extensive portfolio of basic research on pain is potentially relevant to TMJDs, and NIH did not classify all of its basic pain research as TMJD-related. NIH is developing a new process for classifying its research by disease or condition, including TMJDs, that is expected to be implemented in phases by all institutes and centers beginning with fiscal year 2008 data. NIH expects this system to result in greater consistency across institutes and centers in estimates of obligations, including TMJD-related estimates.

¹⁰See, for example, L. A. Aaron, M. M. Burke, and D. Buchwald, "Overlapping Conditions Among Patients With Chronic Fatigue Syndrome, Fibromyalgia, and Temporomandibular Disorder," *Archives of Internal Medicine*, vol. 160 (2000).

¹¹See, for example, T. T. Dao, K. Knight, and V. Ton-That, "Modulation of Myofascial Pain by the Reproductive Hormones: A Preliminary Report," *Journal of Prosthetic Dentistry*, vol. 79, no. 6 (1998); M. P. Warren and J. L. Fried, "Temporomandibular Disorders and Hormones in Women," *Cells, Tissues, Organs*, vol. 169, no. 3 (2001); and N. Landi, I. Lombardi, D. Manfredini, E. Casarosa, K. Biondi, M. Gabbanini, and M. Bosco, "Sexual Hormone Serum Levels and Temporomandibular Disorders: A Preliminary Study," *Gynecological Endocrinology*, vol. 20, no. 2 (2005).

primarily by grants, but also through cooperative agreements and contracts.¹² NIH also supports intramural research, conducted by scientists working in its own laboratories and clinical center. Approximately 10 percent of NIH's budget supports intramural research.¹³

NIH awards a variety of types of grants to support extramural research, and each type of grant supports a specific type of research activity. For example:

- Some grants support discrete research efforts by specific investigators. The most common type of grant—a research project grant—is used to support a specified, circumscribed project, traditionally under the direction of a single principal investigator.¹⁴ The research project grant is typically awarded for a period of 3 to 5 years to support research in an area representing the investigator's specific interest and competencies.¹⁵ Small research grants support research that can be carried out in a short period of time with limited resources. Exploratory or developmental grants are designed to encourage the development of new research activities in the early and conceptual stages.
- Other NIH grants, including center and research program project grants, support multiple research efforts. For example, a research program project grant is designed to support a broadly based, multidisciplinary program that has a specific major objective or basic theme. This type of grant is used to support research that generally involves the organized efforts of several investigators conducting related research projects. Similarly, a general clinical research center grant is designed to support a research unit within a hospital, for example, where scientists conduct studies on a wide range of issues.¹⁶ Another type of grant—a specialized center grant—is designed to support multidisciplinary research, both basic and clinical, on a specific disorder or biomedical issue.
- NIH also provides fellowships and research career development grants to help individuals obtain research training or pursue their research careers. One such grant helps individuals who have completed doctoral training obtain additional research training to broaden their scientific background and increase their potential for research.
- NIH also has conference grants to support organized meetings where people exchange information.

(See table 1 for examples of NIH's grants and the types of research activities they support.)

¹²NIH awards a cooperative agreement rather than a grant when it anticipates that there will be substantial scientific or programmatic involvement of NIH staff after funds are awarded. Substantial involvement means that, after the cooperative agreement is awarded, scientific or program staff will assist, guide, coordinate, or participate in project activities. In contrast to grants and cooperative agreements, which support research plans developed by extramural investigators, NIH research and development contracts are awarded to academic institutions and other nonprofit and commercial organizations to procure specific activities for scientific inquiries in particular areas of research and development needed by NIH.

¹³The remaining 6 percent of NIH's budget is used for NIH buildings and facilities and the National Library of Medicine, among other things.

¹⁴NIH began accepting applications that name multiple principal investigators in February 2007.

¹⁵Typically, grantees develop proposals for multiyear projects for which the first year of funding is provided through competitive grants, with a recommended period of support that can be more than 1 year. For subsequent years, grantees may obtain funding through noncompetitive continuation grants.

¹⁶NIH is currently transitioning from general clinical research center grants to a new type of similar grant called clinical and translational science awards.

Table 1: Examples of Extramural Research Grants

Type of grant	Supported research activities
Research projects	
Research project grant	A discrete, circumscribed project, usually under the direction of a single principal investigator and typically awarded for a period of 3 to 5 years
Small research grant	Research that can be carried out in a short period of time with limited resources
Exploratory/developmental grant	New research activities in the early and conceptual stage
Centers and programs	
Research program project grant	A broadly based, multidisciplinary program that typically has a specific major objective and generally involves several investigators conducting related research
General clinical research center grant	A research unit within a hospital or other inpatient care facility where scientists conduct studies on a wide range of issues
Specialized center grant	Multidisciplinary research, both basic and clinical, on a specific disorder or biomedical issue
Fellowships and research career development	
Postdoctoral individual National Research Service award	Research training for individuals who have completed a doctoral degree
Mentored patient-oriented research career development award	Supervised study and research for clinically trained professionals who have the potential to develop into productive, clinical investigators focusing on patient-oriented research

Source: GAO analysis of information from NIH.

Although most extramural grant applications submitted to NIH for funding are unsolicited—that is, submitted in the absence of a targeted announcement—NIH can signal particular interest in specific areas by issuing targeted funding announcements on specific topics of high priority. Targeted funding announcements include, for example, program announcements and requests for applications.¹⁷ Program announcements describe areas of research that NIH is interested in funding, but for which it has generally not set funds aside. Requests for applications describe areas of research for which NIH has set funds aside.

NIH evaluates grant applications for extramural research support using a two-tiered system of peer review that reflects assessment of key factors, such as scientific merit and NIH priorities. First, applications are reviewed for scientific and technical merit by review groups composed primarily of nongovernment scientists who are experts in relevant fields of research. Based on this review, each application is given a “priority score” that becomes the main determinant in whether an applicant will eventually receive funding for the research proposal. A second level of peer review is conducted by the relevant institute’s or center’s National Advisory Council or Board, which includes both scientific and lay representatives. The council or board reviews applications not only for scientific and technical merit, but also for their relevance to the institute’s or center’s programs and priorities. Institute and center directors make the final funding decisions among the top priority applications. According to NIH officials, institute and center directors may decide to fund certain applications that fall

¹⁷NIH issues program announcements and requests for applications to signal interest in receiving applications for grants and cooperative agreements. NIH issues requests for proposals to solicit contract proposals. Funding announcements are issued by one or more institute(s) or center(s). Other institutes and centers with potential interest in funding some of the research may be listed on the funding announcement.

just outside the normal priority score percentile cutoff if the research is of particular interest to the institute or center—for example, if the research falls within one of the high-priority areas described in one of the institute’s or center’s targeted funding announcements.¹⁸

NIH’s Structure for Supporting Research on TMJDs

Within NIH, NIDCR has primary responsibility for research on TMJDs.¹⁹ Other institutes and centers may fund TMJD-related research to the extent that the research is consistent with their programs and priorities.²⁰ For example, the National Institute of Arthritis and Musculoskeletal and Skin Diseases may fund research on those TMJDs associated with arthritis, and the Office of Research on Women’s Health (ORWH), within the Office of the Director, may contribute funding toward research on gender differences in TMJDs.

Two NIH committees facilitate coordination among institutes and centers on issues related to TMJDs. First, the Temporomandibular Muscle and Joint Disorders Interagency Working Group is a committee that meets annually to facilitate cooperation, communication, and collaboration among NIH institutes and centers and other federal agencies that conduct or support TMJD-related activities.²¹ Second, NIH’s Pain Consortium seeks to enhance pain research across NIH and to promote collaboration among institutes and centers with programs and activities addressing pain, including the pain associated with TMJDs. These committees provide a forum for the exchange and dissemination of information and can facilitate the coordination of activities, including the development of targeted funding announcements, across institutes and centers.

NIH Supported a Wide Range of TMJD-Related Research

NIH has supported a range of different types of research addressing a variety of questions related to TMJDs. We identified 170 TMJD-related projects supported by NIH during fiscal years 2002 through 2006.²² These projects varied in the types of research activities involved, the institutes and centers that supported them, and the questions the research was designed to investigate.

¹⁸In some cases, research is cofunded by two or more institutes and centers after separate review by each of the funding institute’s and center’s council or board. In these cases, one institute or center—the primary funding institute or center—assumes administrative responsibility for the grant. Applications submitted in response to requests for applications—for which funds have been set aside—are reviewed as a group.

¹⁹NIDCR’s mission is to improve oral, dental, and craniofacial health through research, research training, and the dissemination of information.

²⁰Of the 27 institutes and centers, 24 have the authority to award grants.

²¹In addition to members from NIH, this working group includes representatives from other federal agencies, including the Agency for Healthcare Research and Quality, the Food and Drug Administration, the Centers for Disease Control and Prevention, and the Department of Defense. Nonfederal representatives from patient advocacy groups and academia participate as nonvoting observers.

²²Some of these projects were scheduled to end after fiscal year 2006.

NIH supported a variety of research activities related to TMJDs. Of the 170 projects we identified, 55 were extramural research project grants. In addition, we found that NIH supported extramural centers and research program projects (2 specialized centers, 1 comprehensive center, 1 research program project, and 56 subprojects of other research program projects or centers),²³ extramural fellowships and research career programs, including career development awards²⁴ (17 projects), extramural conferences (6 projects), other types of extramural research (such as small research grants and grants for exploratory or developmental research—27 projects, including 1 research and development contract and 3 cooperative agreements), and intramural research (5 projects). See enclosure II for a list of the 170 NIH-supported projects related to TMJDs funded from fiscal years 2002 through 2006.

Most of the TMJD-related projects supported by NIH from fiscal years 2002 through 2006 were funded through NIDCR. Nine other NIH institutes and centers and the Office of the Director also funded TMJD-related projects. Specifically, NIDCR was the primary sponsor of 103 of the 170 projects we identified—that is, NIDCR had administrative responsibility for these projects. Other institutes and centers that were primary sponsors of TMJD-related research included the National Center for Research Resources (48 projects), National Institute of Biomedical Imaging and Bioengineering (6 projects), National Institute of Neurological Disorders and Stroke (4 projects), National Center for Complementary and Alternative Medicine (3 projects), National Institute of Arthritis and Musculoskeletal and Skin Diseases (2 projects), National Institute of Mental Health (2 projects), National Institute of Child Health and Human Development (1 project), and National Institute on Drug Abuse (1 project). Some of these institutes and centers, along with the National Institute on Deafness and Other Communication Disorders and two offices within the Office of the Director—ORWH and the Office of Rare Diseases—also provided additional support for TMJD-related research by cofunding one or more of these projects.

NIH supported research that addressed a wide range of questions related to TMJDs, including topics identified by the panel from the 1996 Technology Assessment Conference as research needs. NIH supported projects to address such questions as the prevalence of TMJD signs and symptoms, predisposing and precipitating conditions, treatment outcomes, and gender differences in TMJDs and related comorbid conditions. NIH also supported basic research on questions about such issues as pain and biomechanics. These projects included multiple studies on each of several topics that NIDCR officials identified as most critical to advancing a scientific understanding of TMJDs—risk factors, pathophysiology,²⁵ pain mechanisms, the structure and function of the temporomandibular joint, comorbidities, treatments (including early intervention), sex and gender differences in TMJDs, and animal models of TMJDs. Although a few examples cannot illustrate the full range of TMJD-related research supported by NIH from fiscal years 2002 through 2006, the following examples illustrate some aspects of NIH's support for research on questions related to TMJDs:

²³Some institutes and centers reported which specific subprojects of research program projects or centers were TMJD-related; other institutes and centers reported which overall research program projects or centers included TMJD-related subprojects. In this report, we use the term “project” to refer to both overall projects and subprojects unless otherwise specified.

²⁴NIDCR officials identified career development awards as an important means of supporting TMJD-related research.

²⁵Pathophysiology refers to the functional changes that accompany a particular syndrome or disease.

- NIDCR began funding a research project entitled “Orofacial Pain: Prospective Evaluation and Risk Assessment,” or OPFERA in fiscal year 2005. This project, the first large-scale prospective study of TMJDs, is a clinical study intended to identify risk factors that contribute to the development of TMJDs by collecting a wide range of biological and behavioral data from people before they develop these disorders. Researchers plan to evaluate and monitor 3,200 volunteers—people who are initially free from TMJDs—for 3 to 5 years. This project is expected to provide important data about genetic, biological, and psychological factors associated with the development of TMJDs. It is also expected to provide information about the signs, symptoms, and course of these disorders once they do develop. Funded through a cooperative agreement, the research will be conducted at four universities.
- NIH funded a research project entitled “Brief Focused Treatment for TMD: Mechanisms of Action” to obtain information about certain treatments for TMJDs. Specifically, this project was designed to compare the effectiveness of a standard treatment for TMJDs—use of an intraoral splint²⁶ and anti-inflammatory drugs—with and without cognitive-behavioral therapy, as well as to obtain information about predictors of treatment effectiveness. This project was funded by NIDCR and cofunded by ORWH from fiscal years 2003 through 2006. Additional support was provided through a general clinical research center grant from the National Center for Research Resources.
- NIH awarded a grant for a specialized center of research to support interdisciplinary studies, including both clinical and basic research. These studies were designed to address gender-related factors (such as hormones) that influence pain and the development of TMJDs and other pain-related conditions (such as irritable bowel syndrome). This project, entitled “ORWH: SCOR²⁷ on Sex and Gender Factors Affecting Women’s Health,” was managed through the National Institute of Arthritis and Musculoskeletal and Skin Diseases, which also provided some funds for the project; the majority of funds were from ORWH. The project was funded from fiscal years 2002 through 2006.
- A career development award entitled “Spatial and Temporal Characteristics of Central Sensitization in Chronic Pain Diseases” supported research designed to illuminate certain pain mechanisms involved in chronic pain disorders. Specifically, research supported through this award was intended to clarify the conditions under which chronic pain causes an increase in sensitivity to pain, so that painful stimuli are perceived as even more painful, or previously nonpainful stimuli become painful. Funding for this project was awarded by the National Institute of Neurological Disorders and Stroke from fiscal years 2002 through 2006.
- A research project grant entitled “The Role of Tooth Mechanoreceptors in Jaw Movement” provides an example of NIH’s support for research on the biomechanics of the temporomandibular joint. This project was designed to obtain information about the nerves that carry information from deep orofacial regions to the central nervous system, the normal processes involved in sensory feedback from craniofacial nerves, and how

²⁶Temporary use of an intraoral splint is a common, conservative dental treatment for TMJDs. There are different types of such splints. For example, one type is designed to help alter the jaw’s posture to a more open, relaxed, resting position. Another type of intraoral splint attempts to decrease the compression load on the joint.

²⁷SCOR here refers to Specialized Center of Research.

those processes are altered in disorders such as TMJDs. This project was supported by NIDCR from fiscal years 2002 through 2006.

- A career transition award entitled “Accelerated Osteoarthritis in the TMJ of Biglycan/Fibromodilin DKO Mice” supported research designed to identify ways of preventing osteoarthritis of the temporomandibular joint by detecting it and treating it at an early stage. This research on the pathophysiology of TMJDs was designed to be conducted with mice that provide a model of osteoarthritic-like TMJD. It was intended to assess the role of mechanical loading on the progression of osteoarthritis of the temporomandibular joint²⁸ and the biomarkers of osteoarthritis in this joint. It was also designed to examine proteins that are involved in the proliferation and death of cells in the cartilaginous portion of the temporomandibular joint. Funding for this project was awarded by NIDCR in fiscal year 2006.

NIH officials noted that, in addition to supporting research that is specifically related to TMJDs, NIH also supports a wide range of research that is not specifically related to TMJDs, but is nonetheless of potential relevance. For example, NIH supports research on related topics such as pain, gender differences in health, and conditions that are frequently comorbid with TMJDs. Information gained through such research has the potential to contribute to the scientific understanding of TMJDs, even though these projects were not specifically designed to do so.

NIH Plans to Continue Supporting Research on TMJDs

NIH officials told us that they plan to support future research on TMJDs by continuing to fund research applications found to be meritorious, including those submitted in response to targeted funding announcements. Several funding announcements issued from December 2005 through December 2007 signaled NIH’s interest in supporting research in areas involving TMJDs, either by focusing directly on TMJDs or by addressing other areas, such as pain, that could include TMJDs. (See enc. III for a list of the areas of research addressed in the targeted funding announcements.) Specifically, NIH signaled interest in receiving applications in one research area that focused directly on TMJDs—the co-occurrence of TMJDs with other chronic conditions such as chronic fatigue syndrome and fibromyalgia. Three funding announcements on this topic, entitled “Temporomandibular Joint and Muscle Disorders: Pathophysiological Mechanisms Linking Comorbid Conditions,” were identical in scientific scope; they differed in the type of research activity for which support could be made available. One of these funding announcements addressed research project grants, a second addressed small research grants, and the third addressed exploratory/developmental grants.²⁹ NIDCR issued these funding announcements in March and December of 2006, and other institutes indicated potential interest in funding some of this work. These three announcements will expire in May 2009.³⁰

²⁸Mechanical loading involves the exertion of force on the joint.

²⁹As of February 2008, NIH officials reported that they have not funded any TMJD-related research applications in response to these three funding announcements. NIDCR officials reported that they had received 9 such applications, but that none of them were considered to be of sufficient scientific merit to warrant funding. ORWH officials informed us that NIH had not completed its scientific review of applications received in response to these announcements, which have not expired.

³⁰Applications submitted in response to an expired program announcement may be delayed in the review process or returned without review. In contrast, NIH does not accept applications submitted in response to expired requests for applications.

Other targeted funding announcements issued during this same 2-year time period signaled NIH's interest in supporting research in areas that could include—but are not required to include—TMJDs. From December 2005 through December 2007, NIH issued funding announcements addressing 15 other research areas that explicitly noted that TMJDs could be included as a research focus.³¹ The following examples illustrate areas of research addressed in these targeted funding announcements:³²

- In August 2006 and January 2007, NIH's National Institute of Nursing Research, in collaboration with NIH's Pain Consortium, issued a set of funding announcements entitled "Mechanisms, Models, Measurement, & Management in Pain Research." These announcements indicated NIH's interest in receiving applications through early September 2009 to support a wide range of pain research, including basic and clinical pain studies. TMJDs were among several pain conditions—such as headaches, fibromyalgia, and spinal cord injury pain—that were identified as being of special interest. These funding announcements invited researchers to submit applications that could address TMJDs, but did not require them to do so. The funding announcements issued for this area of research were identical in scientific scope and also involved three separate types of research activities—research project grants, small research grants, and exploratory/developmental grants.
- In December 2005, NIDCR issued a set of funding announcements entitled "Drug Delivery Systems for Orofacial Disease." These announcements expressed interest in receiving applications for small business innovation research grants and small business technology transfer grants, which support research and development projects that could result in commercial projects or services. The targeted funding announcements indicated NIH's interest in supporting research on the design and development of novel delivery systems for drugs to treat oral diseases (such as tooth decay and periodontal disease) or TMJDs. The announcements expire in May 2008.

In addition to signaling interest in supporting research in these specific substantive areas, NIH has also encouraged institutions to submit applications to support training programs that could address TMJDs. NIH officials and representatives of advocacy groups told us that the scientific workforce has not always included as many qualified TMJD researchers as would be desirable. Although institutional training grants are not designed to guarantee that individuals obtain training as TMJD researchers, such grants can create opportunities to do so. NIH issued a funding announcement in January 2006 entitled "Institutional Grants for Research Training in Biomedical Informatics" that signaled its interest in receiving

³¹The following institutes issued funding announcements for these areas of research: National Cancer Institute, National Institute of Arthritis and Musculoskeletal and Skin Diseases, National Institute of Biomedical Imaging and Bioengineering, NIDCR, National Institute of Neurological Disorders and Stroke, National Institute of Nursing Research, and National Institute on Deafness and Other Communication Disorders. NIH's ORWH and Office of Behavioral and Social Sciences Research—both within the Office of the Director—each issued one of these funding announcements.

³²As of February 2008, NIDCR officials reported that they funded 2 of 3 TMJD-related research applications submitted in response to the targeted funding announcement "Neurobiology of Persistent Pain Mediated by the Trigeminal Nerve" and 10 of 43 TMJD-related applications submitted in response to "New Models of Pain Relevant to the Trigeminal System." For the other targeted funding announcements, NIH officials reported that they had either not received TMJD-related research applications in response, or had not received TMJD-related applications considered to be of sufficient scientific merit to warrant funding. NIH may also fund additional applications on these areas of research that are not submitted in response to these targeted funding announcements.

applications through mid-March 2006 to fund continuing-education training grants.³³ These grants assist professional schools and other public and nonprofit institutions to establish, expand, or improve programs of continuing professional education. This announcement explicitly mentioned that training in TMJDs could be included as a specialized track offered through the proposed training programs.

NIH officials also reported that they expect to issue additional targeted funding announcements involving TMJDs as the agency identifies appropriate areas for emphasis. In particular, agency officials told us that they are exploring the merits of encouraging research that adopts a systems approach to TMJDs. According to NIH officials, a systems approach involves interdisciplinary research that explicitly seeks to enhance the understanding of TMJDs by integrating information from multiple domains, such as genetics, physiology, biochemistry, and psychology. In September 2007, the Temporomandibular Muscle and Joint Disorders Interagency Working Group participated in a meeting of a Working Group of NIDCR's National Advisory Dental and Craniofacial Research Council to discuss the systems approach to TMJDs and provide guidance for the development of recommendations for the council's consideration. NIH officials told us that as of February 2008, no decisions had been reached about this issue.

NIH officials stressed that targeted funding announcements are a way for NIH to signal interest in particular areas of research, and that they plan to continue to support research investigating a broad range of questions about TMJDs. They also emphasized that their future support for research on TMJDs will continue to be driven by factors in addition to their targeted funding announcements. In particular, most future research on TMJDs is likely to be investigator-initiated and will reflect the scientific developments that result from research that is currently underway.

Agency Comments


We provided a draft of this report to HHS for comment. The department provided technical comments, which we incorporated as appropriate.

We are sending copies of this report to the Secretary of HHS, the Director of NIH, relevant congressional committees, and interested parties. We will also make copies available to others upon request. In addition, this report will be available at no charge on GAO's Web site at <http://www.gao.gov>.

³³As of February 2008, NIH officials reported that one application was received and funded in response to this targeted funding announcement that could provide specialized training in issues of relevance to TMJDs.

If you or your staff have any questions concerning this report, please contact me at (202) 512-7114 or crossem@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made major contributions to this report are listed in enclosure IV.

Sincerely yours,

A handwritten signature in black ink that reads "Marcia Crosse". The signature is written in a cursive style with a long horizontal line extending to the right.

Marcia Crosse
Director, Health Care

Enclosures (4)

Scope and Methodology

To identify the research activities related to temporomandibular joint and muscle disorders (TMJD) supported by the National Institutes of Health (NIH) from fiscal years 2002 through 2006, we reviewed a list of TMJD-related projects provided by NIH and interviewed NIH officials.¹ NIH prepared this list when developing its estimate of funding for this set of disorders during these years.² Because we learned that some NIH institutes and centers did not begin reporting TMJD-related projects until after fiscal year 2002³ and that institutes and centers differed in their methods for determining whether projects were TMJD-related, we validated the list of projects NIH provided. In addition, we took steps to determine whether NIH had sponsored other relevant projects that were not included on its list.

To validate information on NIH's list and confirm that a project was TMJD-related, we reviewed an abstract or other documentation, such as a progress report, for each listed project. We also interviewed agency officials about how NIH's institutes and centers determined which projects were related to TMJDs. We did not develop independent criteria for what constitutes TMJD-related research; instead, we relied on NIH's scientific expertise. For example, research on pain mechanisms can be directly or indirectly relevant to TMJDs, and we relied on NIH officials to determine which of these projects to count. For each listed project, we confirmed that the abstract or other documentation either addressed TMJDs directly or addressed topics that we determined had been among NIH's research priorities for TMJDs from fiscal years 2002 through 2006. These topics included the biomechanics of the jaw; conditions that are comorbid with TMJDs (including irritable bowel syndrome, chronic fatigue syndrome, fibromyalgia, multiple chemical sensitivity, and sleep disorders); craniofacial or orofacial pain; gender differences in TMJDs or pain; pain mechanisms and management; reconstruction technologies related to the temporomandibular joint and surrounding orofacial areas; risk factors for TMJDs; and the trigeminal system (which involves the motor and sensory nerves for the mandibular region). When our review of the abstracts or other documentation did not readily confirm that a project was TMJD-related, we sought clarification from NIH officials. In some of these cases, NIH officials agreed that projects had been mistakenly listed as TMJD-related, and we removed those projects from our list. As one example, a project that NIH had originally listed as TMJD-related was designed to study tibial muscular dystrophy. That project had been mistakenly included on NIH's list because the abstract referred to tibial muscular dystrophy by the acronym, TMD, which is also an acronym that can refer to temporomandibular joint and muscle disorders.

In addition, we took steps to ensure that we identified relevant projects that were not included on NIH's list. Specifically, we compared its list to one that we developed through a keyword search of the Department of Health and Human Services' Computer Retrieval of Information on Scientific Projects (CRISP) database.⁴ We searched for the keywords

¹When we did our work, fiscal year 2006 was the most recent year for which NIH could provide full information about the TMJD-related projects it funded.

²Each year, NIH prepares an estimate of its funding for research on TMJDs and other disorders for public distribution.

³For example, the National Institute of Neurological Disorders and Stroke began reporting TMJD-related research in fiscal year 2004.

⁴CRISP is a publicly available database that includes information about, and abstracts for, projects funded by NIH.

Enclosure I

“temporomandibular,” “TMD,” and “TMJ” (which would include TMJD).⁵ As we previously reported,⁶ however, and NIH officials confirmed, there are limits to the reliability and validity of information derived from the CRISP database. For example, CRISP abstracts are based on grant applications, and not actual research activities. Researchers may revise their plans after submitting an application. Thus, if a researcher initially planned to include a study related to TMJDs as part of a broader proposal, but eliminated that study from the research plan before NIH funded it, the project could be incorrectly identified as TMJD-related through a search of CRISP. When our search of CRISP identified projects that were not on NIH’s list of TMJD-related projects, we reviewed the abstract. If the abstract appeared to be TMJD-related, we sought clarification from NIH officials. In some of these cases, NIH officials agreed that projects were TMJD-related, and so we added them to our list. For example, one project had been omitted from the list because the institute that funded the project did not consider TMJDs to be a primary focus of the research. NIH officials agreed, however, that the project was relevant to TMJDs, and we included it in our list. Similarly, when NIH’s list included a project that we had not identified through our search of CRISP—as could happen when a researcher who received funding to support research that was not expected to address TMJDs subsequently conducted studies that were TMJD-related—we resolved the discrepancy with NIH officials.

As another step to validate our list of TMJD-related projects, we identified specific research projects that appeared on NIH’s list as TMJD-related during 1 or more fiscal years and, based on available project documentation, appeared to have been underway during 1 or more preceding fiscal years, but were not included on NIH’s list as TMJD-related during those years. We sought clarification from NIH for these projects, and in some cases, NIH officials agreed that the project had been mistakenly omitted from their list for 1 or more fiscal years. We included those additional years of support in our list. As an example, NIH’s National Center for Research Resources (NCRR) had not previously developed a list of TMJD-related projects for fiscal years 2003 or 2004. In response to our request for clarification about projects that it listed for fiscal year 2005, but not for previous years, NCRR staff reviewed their files for fiscal years 2002 through 2006. They then provided us with a revised list of TMJD-related projects and supporting documentation for each of those years. We adjusted our list of projects accordingly.

It is possible that NIH supported research projects related to TMJDs from fiscal years 2002 through 2006 that are not included in our final list. Our search of CRISP would not identify all TMJD-related research supported by NIH because the keywords we used to search CRISP would not necessarily appear in each abstract. For example, research on the biomechanics of the jaw could be of direct relevance to TMJDs, even if the abstract or other information in CRISP did not include the keywords “temporomandibular,” “TMD,” or “TMJ.” If a TMJD-related project was not on NIH’s list of TMJD-related projects and the CRISP entry for a TMJD-related project did not include the words “temporomandibular,” “TMJ,” or “TMD,” then we would not have identified it. Based on these analyses and discussions, we determined that our final list of TMJD-related projects supported by NIH from fiscal years 2002 through 2006 was sufficiently reliable and valid for our purposes.

⁵In this report, we use the acronym TMJDs to refer to this set of disorders. Some experts use the acronyms TMJ or TMD instead.

⁶GAO, *Chronic Fatigue Syndrome: CDC and NIH Research Activities Are Diverse, but Agency Coordination Is Limited*, GAO/HEHS-00-98 (Washington, D.C.: June 2, 2000).

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To identify NIH's plans to support future research on TMJDs, we reviewed public announcements of NIH research funding opportunities issued from December 2005 through December 2007. We identified relevant targeted funding announcements by searching NIH's online Guide for Grants and Contracts⁷ for the keywords "temporomandibular," "TMD," "TMJ," and "TMJD."⁸ We asked NIH whether it had funded TMJD-related research applications submitted in response to the targeted funding announcements.⁹ We also interviewed NIH officials about their plans to support future research on TMJDs, including potential funding announcements. In addition, we interviewed representatives of three TMJD advocacy groups to help us understand their perspectives on TMJD-related research. These advocacy groups were the American Alliance of TMD Organizations, the Jaw Joints & Allied Musculo-Skeletal Disorders Foundation, and the TMJ Association.

We conducted this performance audit from February 2007 through March 2008 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

⁷NIH's online Guide for Grants and Contracts is available through NIH's Office of Extramural Research Web site at <http://grants.nih.gov/grants/guide/index.html> (accessed on Jan. 16, 2008).

⁸We excluded two targeted funding announcements on TMJDs. One of these funding announcements notified applicants who have a currently active NIH grant of an option to obtain supplemental funding to support travel or workshop activities to support exchange, training, and research collaborations between scientists in the United States and Japan. The second excluded funding announcement was for institutional training grants, which are not designed to support specific research activities.

⁹We did not ask NIH to provide this information for two targeted funding announcements—both requests for applications—with a peer review date in 2008, for which funding decisions were not made prior to the completion of our audit work. Applications submitted to NIH in response to requests for applications are reviewed as a group in a onetime competition. In contrast, applications submitted in response to program announcements are not reviewed in a onetime competition.

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Research Projects Related to Temporomandibular Joint and Muscle Disorders Supported by the National Institutes of Health

We identified 170 projects related to temporomandibular joint and muscle disorders (TMJD) funded by the National Institutes of Health (NIH) from fiscal years 2002 through 2006. These projects were funded or cofunded by two offices within the Office of the Director—the Office of Research on Women’s Health (ORWH) and the Office of Rare Diseases (ORD)—and by the following NIH institutes and centers:

- National Center for Complementary and Alternative Medicine (NCCAM),
- National Center for Research Resources (NCRR),
- National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS),
- National Institute of Biomedical Imaging and Bioengineering (NIBIB),
- National Institute of Child Health and Human Development (NICHD),
- National Institute of Dental and Craniofacial Research (NIDCR),
- National Institute of Mental Health (NIMH),
- National Institute of Neurological Disorders and Stroke (NINDS),
- National Institute on Deafness and Other Communication Disorders (NIDCD), and
- National Institute on Drug Abuse (NIDA).

These projects involved a variety of types of research activities. Specifically, these projects included the following:

- extramural research projects, which are discrete, specified, circumscribed projects performed by a particular investigator(s) in an area representing the investigator’s specific interest and competencies (table 2);
- extramural centers and research program projects, which involve multiple research activities or subprojects (table 3);¹
- extramural fellowships and research career program grants, which support individuals as they obtain research training or pursue research careers (table 4);
- extramural conferences, which are organized meetings where people exchange information (table 5);
- other extramural research activities (table 6); and
- intramural research projects (table 7).

¹Some institutes and centers reported which specific subprojects of research program projects or centers were TMJD-related; other institutes and centers reported which overall research program projects or centers included TMJD-related subprojects. In this report, we use the term “project” to refer to both overall projects and subprojects unless otherwise specified.

Table 2: NIH-Supported Extramural Research Projects Related to TMJDs, Fiscal Years 2002–2006

Fiscal year(s)	Primary funding institute or center	Cofunding institute, center, or office	Project title
2002	NIDCR	None	Fibromyalgia, Depression and Myofascial TMD
2002	NIDCR	None	Four Treatment Strategies for TMJ Disk Displacement
2002	NIDCR	None	Gonadal Steroid Hormonal Regulation of Persistent Pain
2002	NIDCR	None	Menstrual Cycle Effects on TMD Pain and Other Symptoms
2002	NIDCR	None	Nerve-Muscle Interactions during Jaw Muscle Development
2002	NIDCR	None	Pain and Analgesic Response—Sex and Hormone Variations
2002	NIDCR	None	Parafunctional Activity and Temporomandibular Disorders
2002	NIDCR	None	Photopolymerization for Noninvasive Cartilage Tissue
2002	NIDCR	None	Puberty and Gender Differences in Pain Responsivity
2002	NIDCR	None	Regulation of Masticatory Muscle Fiber Phenotype
2002–2003	NIDCR	None	Gender Differences in Pain Sensation and Pain Report
2002–2003	NICHHD	None	Neuronal Control of CGRP Gene Expression
2002–2003	NIDCR	None	Sex vs Gender in Pain Perception
2002–2003	NIDCR	None	Tissue Engineering of the Temporomandibular Joint
2002–2004	NIDCR	None	An Evaluation and Treatment Study of TMD
2002–2004	NIDCR	None	Engineering Skeletal Muscle with Biodegradable Hydrogels
2002–2004	NIDCR	None	Interaction Affecting Craniofacial Muscle Differentiation and Morphogenesis
2002–2005	NIDCR	None	Engineering Joint Scaffolds for Function/Regeneration
2002–2005	NIDCR	None	Kinesthetic Mechanisms in the Trigeminal System
2002–2005	NIDCR	None	Mechanisms of Persistent Temporomandibular Pain
2002–2005	NIDCR	ORWH	Pain Management in Temporomandibular Joint Disorders
2002–2006	NIDCR	None	Estrogen and Inflammation in TMD Pain
2002–2006	NIDCR	None	Mechanical Environment in Mandibular Distraction
2002–2006	NIDCR	None	Nanocrystalline Coatings for Dental TMJ Implants / Nanotechnology in Osseointegration of TMJ Implants
2002–2006	NIDCR	None	The Role of Tooth Mechanoreceptors in Jaw Movement
2003–2005	NIDCR	ORWH	Genotype and TMJD Vulnerability Traits
2003–2005	NIBIB	None	Novel Amino Acid-Based Glass-Ionomer Biomaterials
2003–2006	NIBIB	None	Biomaterials (Mg/Zn/F-BCPs) for Osteoporosis Therapy
2003–2006	NIDCR	None	Bone Growth, Periosteal Migration and Muscle Function
2003–2006	NIDCR	None	Brainstem Mechanisms Controlling Jaw Movements
2003–2006	NIDCR	ORWH	Brief Focused Treatment for TMD: Mechanisms of Action
2003–2006	NIDCR	None	CGRP Control in Trigeminal Neurons in Vitro and in Vivo
2003–2006	NIDCR	None	Cytokine Pathways and Orofacial Pain
2003–2006	NIDCR	ORWH	Estrogenic Regulation of Inflammation Related to TMJD
2003–2006	NIDCR	None	Inflammation of TMJDs: Role of Biomechanical Signals
2003–2006	NINDS	None	Inflammation-Induced Plasticity in Sensory Neurons
2003–2006	NIBIB	None	Injectable Osteoinductive Biodegradable Composites
2003–2006	NIDCR	None	Integrins and Mechanoreception in the Inflamed TMJ

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Fiscal year(s)	Primary funding institute or center	Cofunding institute, center, or office	Project title
2003–2006	NIDCR	ORWH	Neuronal Plasticity Related to TMD and Fibromyalgia
2003–2006	NIDCR	None	Peripheral NMDA Receptors and TMD Pain Mechanisms
2003–2006	NIDCR	None	RAGE, Inflammation and Temporomandibular Joint Disorders
2003–2006	NIDCR	None	Regulation of Mandibular Condylar Cartilage Growth
2003–2006	NIDCR	None	Stem Cell-Driven Regeneration of the Mandibular Joint
2003–2006	NIDCR	None	Trigeminal Pain Pathways
2004–2006	NIDCR	ORWH	Hormonal Cycles in Women: Effects on TMD Pain & Symptoms
2004–2006	NIDCR	None	TMJ Disc Regeneration
2005–2006	NIDCR	None	COMT and β AR Polymorphism and Development of Painful TMD
2005–2006	NIDCR	None	Craniofacial Tissue Engineering
2005–2006	NIBIB	None	Integrin-Specific Implant Surfaces for Bone Repair
2005–2006	NIDCR	None	Optimizing Mandibular Scaffold Modulus/Porosity Balance
2005–2006	NIDCR	None	Peripheral Receptor Mechanisms in Orofacial Muscle Pain
2005–2006	NIDCR	None	Sex Steroids, and TMJ Pain
2006	NIDCR	None	CGRP Regulation of iNOS and MAP Kinases/Phosphatases in Trigeminal Ganglia Glia
2006	NIDCR	None	Effects of Gender and TMD on Mandibular Mechanics
2006	NIDCR	None	Neuron-Glia Interactions in Trigeminal Ganglia as a Basis for Future Therapy

Source: GAO analysis of data from NIH.

Note: The extramural research project grants listed in this table are known as R01 grants. (NIH identifies types of projects using a specific letter, generally followed by a two-digit number.) Each such grant is made to support a discrete, specified, circumscribed project to be performed by a particular investigator(s) in an area representing the investigator's specific interest and competencies. Some of these projects are scheduled to end after fiscal year 2006.

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Table 3: NIH-Supported Extramural Centers and Research Program Projects Related to TMJDs, Fiscal Years 2002–2006

Fiscal year(s)	Primary funding institute or center	Cofunding institute, center, or office	Project title	Type of grant
2002	NIDCR	None	EEG Studies of Vibrotactile Adaptation	Research program project ^a (subproject)
2002	NCRP	None	Effects of Dextromethorphan, Naloxone and Fentanyl on Experimental Pain Stimuli	General clinical research center ^b (subproject)
2002	NCRP	None	HPA Axis Dysregulation in Fibromyalgia	General clinical research center ^b (subproject)
2002	NCRP	None	Investigate the Safety & Efficacy of LY293558 in Patients with Chronic Neuropathic Pain	General clinical research center ^b (subproject)
2002	NCRP	None	Investigate the Safety / Efficacy of LY293558 in Patients with Chronic Neuropathic Pain	General clinical research center ^b (subproject)
2002	NCRP	None	Mechanisms of Action in TMD Treatment	General clinical research center ^b (subproject)
2002	NIAMS	None	Multipurpose Arthritis and Musculoskeletal Diseases Center	Comprehensive center ^c
2002	NCRP	None	Neuroendocrinology of Masticatory Muscle Disorders in Women	General clinical research center ^b (subproject)
2002	NIDCR	None	Pain Sensitivity and the Development of Temporomandibular Disorders	Research program project ^a (subproject)
2002	NIDCR	None	Self Care Intervention for TMD	Research program project ^a (subproject)
2002	NIDCR	None	Somatosensory Channel Interactions in Trigeminal Nerve-Injured Patients	Research program project ^a (subproject)
2002	NIDCR	None	Vibratory Analgesia in Normals and Persons with Temporomandibular Disorders	Research program project ^a (subproject)
2002–2003	NIDCR	None	Chronic Pain Management in Primary Care	Research program project ^a (subproject)
2002–2003	NCCAM	None	Craniofacial Complementary & Alternative Medicine Center	Specialized center ^d
2002–2003	NIDCR	None	Influence of Belief and Coping on TMD Pain Problems	Research program project ^a (subproject)
2002–2003	NCRP	None	Interactions between the HPA Axis and ANS in Women with Fibromyalgia	General clinical research center ^b (subproject)

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Fiscal year(s)	Primary funding institute or center	Cofunding institute, center, or office	Project title	Type of grant
2002–2003	NCRR	None	Mechanisms in Chronic Multisymptom Illnesses	General clinical research center ^b (subproject)
2002–2003	NCRR	None	Modification of Tonic and Experimental Pain in Fibromyalgia Syndrome	General clinical research center ^b (subproject)
2002–2003	NIDCR	None	Pain in Adolescents: Biologic/Psychosocial Risk Factors	Research program project ^a (subproject)
2002–2003	NCRR	None	Pain Perception in Fibromyalgia	General clinical research center ^b (subproject)
2002–2003	NCRR	None	Pilot Study of Acupuncture in Fibromyalgia	General clinical research center ^b (subproject)
2002–2003	NCRR	None	Regulation of Adrenal Function in Fibromyalgia	General clinical research center ^b (subproject)
2002–2003	NIDCR	None	Role of Female Reproductive Hormones in TMJ Disease	Comprehensive center ^c (subproject)
2002–2003	NIDCR	None	Stress, Adrenergic and Inflammatory Factors in 4 Disorders	Comprehensive center ^c (subproject)
2002–2004	NCRR	None	Genetic Fibromyalgia Study	General clinical research center ^b (subproject)
2002–2004	NCRR	None	Immunoneuroendocrine Response to Tetanus Toxoid	General clinical research center ^b (subproject)
2002–2004	NCRR	None	Mapping of Genes for Fibromyalgia Syndrome	General clinical research center ^b (subproject)
2002–2005	NCRR	None	Factors in Arthritis, CFS, Fibromyalgia & Temporomandibular Disorders	General clinical research center ^b (subproject)
2002–2005	NCRR	None	Physiological Benefits of Psychological Well-Being in Chronic Disease	General clinical research center ^b (subproject)
2002–2005	NCRR	None	The Role of Female Reproductive Hormones in the Etiopathogenesis of TMJ Diseases	General clinical research center ^b (subproject)
2002–2006	NCRR	None	Fibromyalgia: Central Factors in Its Etiopathogenesis—Second Cycle	General clinical research center ^b (subproject)
2002–2006	NCRR	None	Neuroendocrine Alterations in Fibromyalgia and IBS	General clinical research center ^b (subproject)
2002–2006	NIAMS	ORWH	ORWH: SCOR on Sex and Gender Factors Affecting Women’s Health	Specialized center ^d

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Fiscal year(s)	Primary funding institute or center	Cofunding institute, center, or office	Project title	Type of grant
2002–2006	NCR	None	Sex-Related Determinants of Pain Responses in Fibromyalgia and Temporomandibular Disorders / Sex-Related Determinants of Pain Responses in Fibromyalgia-Family Study	General clinical research center ^b (subproject)
2003–2004	NCR	None	Autonomic Arousal and Abnormal Pain Sensitivity in Fibromyalgia	General clinical research center ^b (subproject)
2003–2004	NCR	None	Cerebrospinal Fluid Neuropeptides in Fibromyalgia	General clinical research center ^b (subproject)
2003–2004	NCR	None	Effect of Analgesics on Experimental Pain	General clinical research center ^b (subproject)
2003–2004	NCR	None	Optimizing Fibromyalgia Self Management	General clinical research center ^b (subproject)
2003–2005	NCR	None	Mapping Genes for Fibromyalgia Syndrome	Biotechnology resource grant ^e (subproject)
2003–2006	NCR	None	Pain Management in Temporomandibular Joint Disorders	General clinical research center ^b (subproject)
2003–2006	NCR	None	Sensory Testing in Patients with Chronic Musculoskeletal Pain Syndromes	General clinical research center ^b (subproject)
2004	NCR	None	Real-Time fMRI Directed Modulation of Pain Perception and Brain Activation in Chronic Pain	Biotechnology resource grant ^e (subproject)
2004–2005	NCR	None	Beneficial Exercise and Diet Effects in Fibromyalgia with Pyridostigmine	General clinical research center ^b (subproject)
2004–2005	NCR	None	Evaluation of Sleep Dysfunction in Fibromyalgia	General clinical research center ^b (subproject)
2004–2005	NCR	None	Functional MRI Study of Cognition in Patients with Lupus and Fibromyalgia	General clinical research center ^b (subproject)
2004–2005	NCR	None	Testing for Single Nucleotide Polymorphisms Associated with Fibromyalgia	General clinical research center ^b (subproject)
2004–2006	NCR	None	Brief Focused Treatment for TMD: Mechanisms of Action	General clinical research center ^b (subproject)
2004–2006	NINDS	None	CNS Processes Underlying Pain Regulation and Persistence	Research program project ^a
2004–2006	NCR	None	Long-Term FMS Self-Management	General clinical research center ^b (subproject)
2004–2006	NCR	None	Subject Registry: Interdisciplinary Studies of Chronic Multi-Symptom Illnesses	General clinical research center ^b (subproject)

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Fiscal year(s)	Primary funding institute or center	Cofunding institute, center, or office	Project title	Type of grant
2005	NCRR	None	Cardiovascular Disease Risk in Young Rheumatoid Arthritis Patients	General clinical research center ^b (subproject)
2005	NCRR	None	University of Kentucky Center of Biomedical Research Excellence: Pilot Projects	Exploratory grant ^f (subproject)
2005–2006	NCRR	None	Effectiveness of EEG Biofeedback in the Treatment of Fibromyalgia	General clinical research center ^b (subproject)
2005–2006	NCRR	None	Pain Mechanisms in Chronic Multi-Symptom Illnesses	General clinical research center ^b (subproject)
2005–2006	NCRR	None	Peripheral and Central Sensitization after Eccentric Muscle Exercise	General clinical research center ^b (subproject)
2006	NCRR	None	GHRH Perturbations in Fibromyalgia	General clinical research center ^b (subproject)
2006	NCRR	None	Immunological and Genetic Analysis of Autoinflammatory Genes in Fibromyalgia	General clinical research center ^b (subproject)
2006	NCRR	None	Locus of Pain Control: Neural Substrates and Modifiability	General clinical research center ^b (subproject)
2006	NCRR	None	Mechanisms of Acupuncture Analgesia: A (fMRI) and (PET) Study	General clinical research center ^b (subproject)
2006	NCRR	None	Sleep Disturbance and Pain Sensitivity in Chronic Pain	General clinical research center ^b (subproject)

Source: GAO analysis of data from NIH.

Notes: Grants for general clinical research centers are known as M01 grants; research program projects and centers are in NIH's category of P grants. (NIH identifies types of projects using a specific letter, generally followed by a two-digit number.) These grants support multiple research activities or subprojects. NCRR and NIDCR reported these grants at the subproject level; NCCAM, NIAMS, and NINDS reported them at the overall center level. Some of these projects are scheduled to end after fiscal year 2006.

^aA research program project grant is designed to support a broadly based, multidisciplinary program that has a specific major objective or basic theme and generally involves the organized efforts of several investigators conducting related research projects.

^bA general clinical research center grant is designed to support a discrete research unit within a hospital or other inpatient care facility where scientists conduct studies on a wide range of issues. Covered costs include operational costs, such as equipment, and supplies.

^cA comprehensive center grant is designed to bring together related facilities within a specific community to achieve such goals as fostering research and educating professionals about specific disorders.

^dA specialized center grant is designed to support multidisciplinary research, both basic and clinical, on a specific disorder or biomedical issue.

^eA biotechnology research grant is designed to make biotechnological resources available to multiple qualified investigators.

^fAn exploratory grant for a research program project or center is designed to support planning for new programs, expansion or modification of existing resources, or studies of the feasibility of interdisciplinary programs.

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Table 4: NIH-Supported Extramural Fellowships and Research Career Program Grants Related to TMJDs, Fiscal Years 2002–2006

Fiscal year(s)	Primary funding institute or center	Cofunding institute, center, or office	Project title	Type of grant
2002	NIDCR	None	Individual Predoctoral Dental Scientist Fellowship	NIDCR individual predoctoral dental scientist fellowship ^a
2002–2003	NIMH	None	Early Detection and Prevention of Chronic Pain Disability	Research scientist development award—Research ^b
2002–2004	NIDCR	None	Individual Predoctoral Dental Scientist Fellowship	NIDCR individual predoctoral dental scientist fellowship ^a
2002–2004	NIDCR	None	Modulation of TMJ Degradation by Relaxin and Estrogen	Research scientist development award—Research ^b
2002–2004	NIDCR	None	Tissue Engineering of Temporomandibular Joint Cartilage	Career transition award ^c
2002–2006	NINDS	None	Spatial and Temporal Characteristics of Central Sensitization in Chronic Pain Diseases	Mentored patient-oriented research career development award ^d
2003–2006	NIDCR	None	Brainstem Mechanisms of Craniofacial Muscle Pain	Career transition award ^c
2003–2006	NIDCR	None	Molecular Targeting of the Vanilloid-1 Receptor	Career transition award ^c
2004–2006	NIMH	None	Comorbidity of Mental Disorders and Pain	Research scientist award ^e
2004–2006	NINDS	None	Sleep Disturbance and Pain Sensitivity in Chronic Pain	Mentored patient-oriented research career development award ^d
2005–2006	NIDCR	None	Individual Predoctoral Dental Scientist Fellowship	NIDCR individual predoctoral dental scientist fellowship ^a
2005–2006	NIDCR	None	Innovative Minimal Contact Therapy for Reducing TMD Pain	Postdoctoral individual National Research Service award ^f
2005–2006	NIDCR	None	Mechanical Stimulation of Cells in Photopolymerized Gels	Career transition award ^c
2006	NIDCR	None	Individual Predoctoral Dental Scientist Fellowship	NIDCR individual predoctoral dental scientist fellowship ^a
2006	NIDCR	None	Regulation of Genes in Mouse Temporomandibular Joint	Career transition award ^c

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Fiscal year(s)	Primary funding institute or center	Cofunding institute, center, or office	Project title	Type of grant
2006	NIDCR	None	Accelerated Osteoarthritis in the TMJ of Biglycan/Fibromodilin DKO Mice	Career transition award ^c
2006	NIDCR	None	Central Pain Processing in Chronic Face Pain: fMRI Study	Mentored patient-oriented research career development award ^d

Source: GAO analysis of data from NIH.

Notes: Extramural fellowship and research career program grants are in NIH's F and K categories of grants. (NIH identifies types of projects using a specific letter, generally followed by a two-digit number.) Some of these projects are scheduled to end after fiscal year 2006. In addition to the grants listed in this table, NIDCR funded three dentist scientist award grants to institutions to support programs designed to allow newly trained dentists, who were appointed by the institution, to develop independent research skills. These grants could have supported TMJD-related research, but were not necessarily used for such research and therefore are not listed.

^aAn NIDCR individual predoctoral dental scientist fellowship is designed to support integrated dental and graduate research training that leads to attainment of both a Doctor of Dental Surgery or Doctor of Dental Medicine degree and a Doctor of Philosophy degree.

^bA research scientist development award for research is designed to support a researcher who needs additional experience to pursue a commitment to research.

^cA career transition award is designed to support newly trained investigators by facilitating establishment of a record of independent research to sustain or promote a successful research career.

^dA mentored patient-oriented research career development award is designed to support supervised study and research for clinically trained professionals who have the potential to develop into productive, clinical investigators focusing on patient-oriented research.

^eA research scientist award is designed to support a research scientist who is qualified to pursue independent research that would extend the research program of that researcher's institution or direct an essential part of that research program.

^fA postdoctoral individual National Research Service award is designed to support individuals who have completed doctoral training as they broaden their scientific background and extend their potential for research.

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Table 5: NIH-Supported Extramural Conferences Related to TMJDs, Fiscal Years 2002–2006

Fiscal year(s)	Primary funding institute or center	Cofunding institute, center, or office	Project title
2002	NIDCR	NIAMS, NIBIB	Joint and Muscle Dysfunction of Temporomandibular Joint
2004	NIDCR	NIAMS, NIBIB, ORWH, ORD	Advancing Diagnostic Approaches for TMJ Disorders
2004, 2006	NIDCR	None	Craniofacial Skeletal Tissue Engineering Conference
2005	NIDCR	None	ECM in Structure & Function of the Craniofacial Complex
2006	NIDCR	NIBIB	TMJ Bioengineering Conference
2006	NIDCR	NIAMS, NIDA, NIDCD, NINDS, ORWH	A Systems Approach to the Understanding of TMJ as a Complex Disease

Source: GAO analysis of data from NIH.

Note: Conferences are funded as R13 grants, which support organized meetings where people exchange information. (NIH identifies types of projects using a specific letter, generally followed by a two-digit number.) Some of these projects are scheduled to end after fiscal year 2006.

Table 6: Other NIH-Supported Extramural Research Projects Related to TMJDs, Fiscal Years 2002–2006

Fiscal year(s)	Primary funding institute or center	Cofunding institute, center, or office	Project title	Type of grant or other support
2002	NIDCR	None	Cellular and Molecular Targeting of TMJ Destruction	Small research grant ^a
2002	NIDCR	None	K-Opioid Systems—Sex and Pregnancy Linked Differences	First independent research support and transition award ^b
2002–2003	NIDCR	None	Animal Models for TMJ Research: Functional 3-D Loading	Small research grant ^a
2002–2003	NIDCR	None	DentoCAT: Dentomaxillofacial CT Scanner	Small business innovation research grant—phase II ^c
2002–2003	NIDCR	None	Mechanical Stimulation for TMJ Disc Tissue Engineering	Small research grant ^a
2002–2006	NIDCR ^d	NIBIB, ORWH	NIDCR TMJ Implant Registry and Repository	Research and development contract ^e
2002–2006	NIDCR	None	Research Diagnostic Criteria—Reliability and Validity	Research project (cooperative agreement) ^f
2003	NIDCR	None	A 3-D Interactive Atlas of the Human Mandible and TMJ	Small business innovation research grant—phase I ^g
2003–2004	NIDCR	None	A New Nanocomposite Scaffold for TMJ Tissue Engineering	Exploratory/developmental grant ^h
2003–2004	NIBIB	None	Molecular Imprinting to Control Cell Responses	Exploratory/developmental grant ^h
2003–2004	NIDA	None	Recombinant Herpes Injection into Trigeminal Ganglia	Exploratory/developmental grant ^h
2003–2004	NCCAM	None	Shamanic Healing for Women with TMD	Exploratory/developmental grant ^h
2004	NCRR	None	Digitized Transmission Electron Microscope: Temporomandibular Disorders	Biomedical research support shared instrumentation grant ⁱ
2004	NIBIB	None	Incorporating Bone Minerals into Orthopaedic Surfaces	Small business technology transfer grant—phase I ^j
2004	NIDCR	None	Neural Substrates of Adaptive Jaw Movement	Academic research enhancement award ^k
2004	NIDCR	None	Polymer Gel to Treat TMJ Pain	Small business innovation research grant—phase I ^g
2004–2005	NIDCR	ORWH	Mast Cell Role in Masseter Muscle Repair	Exploratory/developmental grant ^h

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Fiscal year(s)	Primary funding institute or center	Cofunding institute, center, or office	Project title	Type of grant or other support
2004–2005	NIDCR	None	Temporomandibular Joint Syndrome in Females	Exploratory/developmental grant ^h
2004–2006	NIDCR	None	A 3-D Interactive Atlas of the Maxilla, Mandible & TMJ	Small business innovation research grant—phase II ^c
2005–2006	NIDCR	None	Mandibular Bone Transport Reconstruction Plate	Small business technology transfer grant—phase II ⁱ
2005–2006	NIDCR	None	Mechanotransduction in Mandibular Tissue Engineering	Small research grant ^a
2005–2006	NIDCR	None	Neural Mechanisms of Chronic Muscle Pain Disorders	Small research grant ^a
2005–2006	NIDCR	None	Orofacial Pain: Prospective Evaluation and Risk Assessment ^m	Research project (cooperative agreement) ^f
2005–2006	NCCAM	None	TCM for TMD: A Multi-Site Whole Systems Trial	Research project (cooperative agreement) ^f
2006	NIDCR	None	A Novel Model of TMJ Osteoarthritis to Define Glial Reactivity in Chronic Pain	Exploratory/developmental grant ^h
2006	NCRR	None	ICP-MS Instrument for Baylor College of Dentistry	Biomedical research support shared instrumentation grant ⁱ
2006	NIDCR	None	Joint Degeneration: Somatic Mosaic Analysis in a Transgenic Mouse	Exploratory/developmental grant ^h

Source: GAO analysis of data from NIH.

Notes: Biomedical research support shared instrumentation grants are known as S10 grants, research and development contracts are designated by N01, and research projects (cooperative agreements) are designated by U01. The remaining projects listed in this table are funded under NIH’s R grant programs. (NIH identifies types of projects—including grants, cooperative agreements, and contracts—using a specific letter, generally followed by a two-digit number.) Some of these projects are scheduled to end after fiscal year 2006.

^aSmall research grants are designed to support research that can be carried out in a short period of time with limited resources.

^bFirst independent research support and transition awards were designed to support newly independent investigators as they initiated their own research and demonstrated the merit of their own research ideas. NIH stopped accepting applications for these awards in 1998.

^cSmall business innovation research grants—phase II are designed to support in-depth development of research and development concepts that have been shown to be feasible in a prior phase of funding.

^dNIDCR did not provide funding for this project in fiscal year 2004.

^eResearch and development contracts support research-related activities conducted under contract to NIH.

^fResearch projects (cooperative agreements) support a discrete, specified, circumscribed project to be performed by a particular investigator(s) in an area representing the investigator’s specific interest and competencies, with the anticipation that NIH staff will have a substantial programmatic involvement in the project.

^gSmall business innovation research grants—phase I are designed to support time- and resource-limited research to establish the technical merit and feasibility of research and development concepts that could lead to commercial products or services.

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^bExploratory/developmental grants are designed to encourage the development of new research activities by supporting the early and conceptual stages of their development.

^cBiomedical research support shared instrumentation grants are designed to make research instruments available to multiple NIH-supported researchers at the same institution.

^dSmall business technology transfer grants—phase I are designed to support time- and resource-limited research by small businesses in cooperation with research institutions to establish the technical merit and feasibility of ideas that have potential for commercialization.

^eAcademic research enhancement awards are designed to support small-scale research projects conducted by faculty in institutions that grant primarily baccalaureate degrees.

^fSmall business technology transfer grants—phase II are designed to support in-depth, time- and resource-limited research by small businesses in cooperation with research institutions on ideas that have potential for commercialization and have been shown to be feasible in a prior phase of funding.

^gThis project was initially entitled “Risk Factors for Onset and Persistence of TMD.”

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Table 7: NIH-Supported Intramural Research Projects Related to TMJDs, Fiscal Years 2002–2006

Fiscal year(s)	Primary funding institute or center	Project title
2002	NIDCR	Clinical Investigations in Infectious & Autoimmune Diseases
2002–2004	NIDCR	Experimental Therapeutics for Chronic Orofacial Pain
2003–2006	NIDCR	Analgesic Mechanisms in Patients with Chronic Pain
2005–2006	NIDCR	Function of Skeletal Matrix Genes
2005–2006	NIDCR	Genetic Studies of Human Craniofacial Diseases

Source: GAO analysis of data from NIH.

Note: Scientists in NIH Intramural Research Programs are generally responsible for conducting original research consonant with the goals of their individual institute or center. Intramural research projects are coded as Z01 projects. (NIH identifies types of projects using a specific letter, generally followed by a two-digit number.)

**Areas of Research Addressed in Targeted Funding Announcements Involving
Temporomandibular Joint and Muscle Disorders
Issued by the National Institutes of Health**

From December 2005 through December 2007, the National Institutes of Health (NIH) released targeted funding announcements—public announcements that describe opportunities for NIH funding—for research in areas that either focused directly on temporomandibular joint and muscle disorders (TMJD) or addressed other areas, such as pain, that could include TMJDs. These targeted funding announcements were issued by the following NIH institutes and offices:

- National Cancer Institute (NCI),
- National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS),
- National Institute of Biomedical Imaging and Bioengineering (NIBIB),
- National Institute of Dental and Craniofacial Research (NIDCR),
- National Institute of Neurological Disorders and Stroke (NINDS),
- National Institute of Nursing Research (NINR),
- National Institute on Deafness and Other Communication Disorders (NIDCD), and
- Office of Behavioral and Social Sciences Research (OBSSR) and the Office of Research on Women’s Health (ORWH), both within NIH’s Office of the Director.

Specifically, NIH released targeted funding announcements from December 2005 through December 2007 covering one area of research that was directly focused on TMJDs—the co-occurrence of TMJDs with other chronic conditions such as chronic fatigue syndrome. During the same 2-year time period, NIH issued targeted funding announcements addressing 15 other areas of research, such as pain, that identified TMJDs as a possible—but not required—research topic.¹ (See table 8 for a list of the 16 areas of research addressed by these targeted funding announcements.)

¹We excluded two targeted funding announcements on TMJDs. One of these funding announcements notified applicants with an active NIH grant of an option to obtain supplemental funding to support travel or workshop activities to support exchange, training, and research collaborations between scientists in the United States and Japan. The other excluded funding announcement signaled interest in funding institutional training grants, which are not designed to support specific research activities.

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Table 8: Areas of Research Addressed in NIH’s Targeted Funding Announcements Involving TMJDs

Area of research ^a	Issuing institute, center, or office ^b	Publication date(s)	Expiration date	Type of grant(s) ^c	Focus of proposed research
Temporomandibular Joint and Muscle Disorders: Pathophysiological Mechanisms Linking Comorbid Conditions	NIDCR	3/24/2006; 12/13/2006 ^d	5/8/2009	Research project grant; ^e small research grant; ^f exploratory/developmental grant ^g	Must involve TMJDs
Developing Complex Models of Oral Health Behavior ^h	NIDCR	12/26/2007	11/15/2008	Exploratory/developmental grant ^g	May involve TMJDs
Collaborative Research on Tinnitus ^h	NIDCD	8/24/2007	10/23/2007	Research project grant ^e	May involve TMJDs
Application of Metabolomics for Translational and Biological Research	NCI	1/17/2007	1/8/2010	Research project grant; ^e exploratory/developmental grant ^g	May involve TMJDs
Mechanisms, Models, Measurement, & Management in Pain Research	NINR	8/31/2006; 1/8/2007 ^d	9/8/2009	Research project grant; ^e small research grant; ^f exploratory/developmental grant ^g	May involve TMJDs
Chronic Fatigue Syndrome: Pathophysiology and Treatment	ORWH	12/22/2006	11/6/2007; 11/17/2007 ⁱ	Research project grant; ^e small research grant; ^f exploratory/developmental grant ^g	May involve TMJDs
Epidemiological and Behavioral Research in Oral Health	NIDCR	12/14/2006	1/8/2010	Research project grant ^e	May involve TMJDs
Research on Mind-Body Interactions and Health	OBSSR	11/21/2006	1/8/2010	Research project grant ^e	May involve TMJDs
Enabling Technologies for Tissue Engineering and Regenerative Medicine	NIBIB	8/1/2006	5/21/2009	Research project grant ^e	May involve TMJDs
New Models of Pain Relevant to the Trigeminal System ^h	NIDCR	5/17/2006; 7/14/2006 ⁱ	11/22/2006	Research project grant; ^e exploratory/developmental grant ^g	May involve TMJDs
Specialized Centers Of Interdisciplinary Research (SCOR) On Sex And Gender Factors Affecting Women’s Health ^h	NIAMS	6/12/2006	9/15/2006	Specialized center grant ^f	May involve TMJDs
Joint Degeneration: Mouse Models	NIAMS	6/9/2006	1/8/2008	Exploratory/developmental grant ^g	May involve TMJDs
NIDCR Clinical Trial Planning Grant	NIDCR	3/17/2006	1/8/2009	Exploratory/developmental grant ^g	May involve TMJDs
International Collaborative Oral Health Research Planning Grant	NIDCR	3/8/2006	1/8/2009	Exploratory/developmental grant ^g	May involve TMJDs

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Area of research ^a	Issuing institute, center, or office ^b	Publication date(s)	Expiration date	Type of grant(s) ^c	Focus of proposed research
Neurobiology Of Persistent Pain Mediated By The Trigeminal Nerve	NINDS	3/3/2006	7/1/2006	Exploratory/developmental grant ^g	May involve TMJDs
Drug Delivery Systems for Orofacial Disease	NIDCR	12/13/2005	5/8/2008	Small business technology transfer grant—phase I and II; ^k Small business innovation research grant—phase I and II ^l	May involve TMJDs

Source: GAO analysis of NIH data.

Notes: This table includes areas of research addressed in targeted funding announcements—program announcements or requests for applications—released from December 2005 through December 2007. Program announcements describe areas of research that NIH is interested in funding, but for which it has generally not set funds aside. Requests for applications describe areas of research for which NIH has set funds aside. No requests for proposals (solicitations for contract proposals) issued during this time frame involved TMJDs. If an announcement was reissued during this time period, we listed the most recent announcement. Expired announcements were included in recognition of the lag time between receipt of an application submitted to NIH in response to a funding announcement and funding decisions reached by NIH.

^aFunding announcements with the same title and scientific scope are grouped together as one area of research. We defined the area of research by the title of the funding announcement(s).

^bWe have listed the issuing organization identified in NIH’s online Guide for Grants and Contracts.

^cIn general, NIH issued a separate funding announcement for each type of grant listed.

^dThe later date applies to the funding announcement for the research project only.

^eResearch project grants support discrete, specified, circumscribed projects to be performed by a particular investigator(s) in an area representing the investigator’s specific interest and competencies.

^fSmall research grants are designed to support research that can be carried out in a short period of time with limited resources.

^gExploratory/developmental grants are designed to encourage the development of new research activities by supporting the early and conceptual stages of their development.

^hThe funding announcements for this area of research were requests for applications. All other funding announcements listed in the table were program announcements.

ⁱThe earlier date applies to the funding announcement for research project grants only. NIH officials told us that the announcement entitled “Chronic Fatigue Syndrome: Pathophysiology and Treatment” that had an expiration date of 11/17/2007 has remained active and will be replaced through an arrangement with the Office of Extramural Research.

^jA specialized center grant is designed to support multidisciplinary research, both basic and clinical, on a specific disorder or biomedical issue.

^kSmall business technology transfer grants—phase I are designed to support time- and resource-limited research by small businesses in cooperation with research institutions to establish the technical merit and feasibility of ideas that have potential for commercialization. Phase II grants are designed to support in-depth, time- and resource-limited research by small businesses in cooperation with research institutions on ideas that have potential for commercialization and have been shown to be feasible in a prior phase of funding.

^lSmall business innovation research grants—phase I are designed to support time- and resource-limited research to establish the technical merit and feasibility of research and development concepts that could lead to commercial products or services. Phase II grants are designed to support in-depth development of research and development concepts that have been shown to be feasible in a prior phase of funding.

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