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ASSESSING RETAINER WEAR AND COMPLIANCE IN THE FIRST TWO YEARS FOLLOWING ACTIVE TREATMENT USING A SURVEY BASED INSTRUMENT

by

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Submitted in partial fulfillment of the requirements for the degree of Master of Science in Dentistry

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Abstract

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The purpose of this descriptive study was to investigate the duration of retainer wear by the range of hours per day, and nights per week orthodontic patients are wearing their retainers in the two years following orthodontic treatment. Twelve hundred patients from four separate orthodontic offices in Ohio were randomly selected for the study. Data were collected by a self-administered questionnaire on the type of retainers being worn, age, gender, length of time since debond, hours per day worn, and nights per week that patients were wearing their retainers. The questionnaire consisted of six questions the majority of which were gathered on a categorical scale, which was analyzed using SPSS. Four hundred twenty-eight responses were received during a six week period for a response rate of thirty six percent. Between nineteen and twenty four months in retention, eighty one percent of patients indicated they were wearing their retainers less than ten hours per day (this includes time worn during sleeping), and forty five percent were wearing them every night of the week. In the first three months

following debond, four percent of patients will not wear their retainers, while between thirteen and eighteen months this number will increase to twenty-one percent. Age, gender and type of retainer worn did not appear to have an effect on hours per day, or nights per week, patients are wearing their retainers. If given a choice between wearing a maxillary Hawley or maxillary trutain retainer, fifty-three percent of patients chose to wear the Hawley retainer, while forty-six percent chose to wear the trutain retainer. Patient compliance with hourly wear was seventy percent in the first three months, while compliance with nightly wear steadily decreased from eighty percent to fifty-six percent, nineteen to twenty four months after debond. The conclusions drawn from this study were that in the two years following debond, the majority of patients continue to wear their retainers each night. Four percent of patients were not wearing their retainers immediately following debond, while between thirteen and eighteen months this number increased to twenty-one percent. After two years of retention, eighty-one percent are wearing their retainers at least one hour per day, while forty-five percent of these patients are wearing their retainers every night. Compliance with hourly wear is lower earlier in the post-treatment period, while compliance with nightly wear steadily decreases throughout the first two years following debond.

DEDICATION

To my Mom and Dad, thank you for your unconditional love, support and guidance. You have set an example to me of hard work, caring, and selflessness that I strive every day to live up to. I love you both so much and am so proud that you are my parents.

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INTRODUCTION

Retention of a corrected malocclusion has always been a challenge in orthodontics, and is a vital component of successful long-term treatment. If retainers are not worn, there is a tendency for the teeth to move from their final position, thus compromising the results of active treatment. The retention phase is almost entirely patient dependent, due to the majority of retainers prescribed being removable appliances. Do patients wear their retainers after the braces are removed, and if so, how much and how often?

The purpose of this descriptive study was to attempt to determine the duration of hours, and nights per week, patients are actually wearing their retainers in the two years following active orthodontic treatment. Compliance in the two years following active treatment was also assessed. Both paper and internet-based surveys are used in an attempt to answer these questions.

REVIEW OF THE LITERATURE

The success of orthodontic treatment depends to a large extent on patient compliance. Successful treatment outcomes often depend on the patient maintaining good oral hygiene, complying with elastic wear, keeping appointments, and following the appropriate diet. Once active orthodontic treatment is completed and the braces removed, a separate phase, which is almost entirely patient dependent, commences. Retention is the phase of orthodontic treatment that attempts to keep teeth in the corrected positions after the removal of orthodontic braces (Littlewood et al. 2006). Retention can be accomplished by using either fixed or removable retainers. If a removable retainer is prescribed and the retention protocol is not followed there is a tendency for teeth to move and perhaps, return to their original position, i.e. relapse (Little et al. 1981,1988,1990,1990). The actual causes of relapse are not fully understood, but are believed to be related to recoil of the gingival fibers holding teeth in the bone, pressures from the lips, cheeks, and tongue, continued growth with aging, and tooth-tooth contacts (Melrose and Millett 1998).

Almost every patient is given a retainer post-treatment in an effort to minimize post orthodontic tooth movement. Though retention is an integral part of every patients overall treatment, there is little agreement on the protocol to be

adopted and which appliance to use. Retainer prescription and design currently seem to be based on a clinician's personal preference, although the three most common retainers prescribed in the United States to date are removable Hawley type, removable vacuum-formed, and fixed lingual retainers (Hughes 2007). There is no defined retention duration, although it has been shown that for gingival and periodontal tissue, it takes on average, a minimum of two hundred thirty two days for fibers around the teeth to remodel (Reitan 1967). This would imply a minimum period of eight months full time wear would be required to allow for reorganization and stability of teeth in the new position. Most clinicians prefer to retain for longer periods of time, sometimes indefinitely (Hughes 2007).

Each clinician has their personal prescription of retainer design and wear. In a recent study it was shown in the United States, maxillary Hawley retainers and mandibular fixed lingual retainers are the most commonly used. Most orthodontists prescribe three to nine months full-time wear of removable retainers, and thereafter advise part-time, but lifetime wear. It was also found that a greater percentage of orthodontists who prescribe Hawley retainers recommend a longer duration of full-time wear as compared to clear thermoplastic retainers (Hughes 2008). In spite of an orthodontist's best effort, the patient is ultimately responsible for compliance with the prescribed

retention protocol. If a patient is non-compliant with removable retainer wear, the current thinking is that relapse is inevitable at some point in the future (Little et al. 1981,1988,1990,1990). Even if the teeth are retained in the corrected position during this period, in the long term the teeth can return to a position of malalignment.

Are there differences in the clinical effectiveness or patient satisfaction between retainer designs, and if so, which design is superior? A recent meta-analysis was attempted with the objective of analyzing the effectiveness of different retention strategies used to stabilize tooth positions after orthodontic braces. After an initial search and screening of possible studies, it was found that only four studies met the inclusion criteria of a randomized controlled or controlled clinical trial. Evaluations of each study were measured using a primary outcome of stability which included both changes in tooth alignment and changes in occlusion. Little's index of irregularity was used, and the assessment needed to be made at least three months after fitting of the retainer. Secondary outcomes used were retainer survival, patient satisfaction, and adverse effects on oral health. After systematically reviewing all possible studies the authors concluded "there is a shortage of high quality published research on orthodontic retention and there is insufficient research data on which to base our

clinical practice of retention at present (Littlewood et al. 2006)." It was also noted that research is required in the specific retention areas of retainer survival and quality of life assessment.

Only one study to date has attempted to evaluate patient satisfaction between the two most common type of removable retainers. Hichens (2007) performed a randomized, controlled, clinical trial set in a single orthodontist's private practice. This study was performed in conjunction with another study conducted by Rowland et al.(2007). Three-hundred ninety-seven patients participated with two-hundred and one patients receiving vacuum-formed retainers (VFR) while one-hundred ninety-six received Hawley retainers. The patients were instructed to wear the Hawley retainers twenty-four hours a day for the first three months, followed by twelve hours per day after from three months to the six month evaluation. The protocol for the VFR was different with twenty-four hours a day wear in the first week, followed by twelve hour a day wear from one week to the six month evaluation. The subjects were asked to return for an evaluation at two intervals: three months and six months after debond. At the six-month review appointment three hundred fifty-five of the original three hundred ninety-seven patients returned for evaluation, giving a completion rate

of eighty-nine percent. No explanations were provided for the dropouts from debond to six months.

These patients also completed self-administered questionnaires while waiting for their scheduled retention appointment after three and six months of wear. A total of three-hundred fifty-two questionnaires were completed at three months, and three-hundred fifty at six months. No significant differences were found in the responses between the three and six month period. They found the majority of subjects showed a preference for VFR's compared to Hawleys. When asked if they were wearing their retainers as instructed, eighty-five percent of Hawley's and ninety-five percent of the VFR group indicated they were. Fifteen percent of the Hawley group indicated they were not wearing their retainer as instructed, while only five percent of VFR's indicated the same. Eight percent of the Hawley group, and seven percent of the VFR group indicated they had lost their retainer at some point. Twenty percent of Hawley retainers and only seven percent of VFR's were reported broken during this time.

Wearing VFRs were reported to cause less embarrassment than Hawleys, especially in regards to speech and appearance. Seventeen percent of patients in the Hawley group indicated they were embarrassed to wear their retainer, while only seven percent of the VFR group reported they were embarrassed. With

this in mind, it is interesting to note that there was no statistically significant difference in the amount of retainer wear away from home. The majority of both groups reported they would always, nearly always, or sometimes wear their retainers away from home. Only seven percent of Hawleys and five percent of VFR patients indicated they never wore their retainer away from home.

Compliance assessment in Health Care

Although numerous definitions regarding compliance have been given, many with different interpretations, the most widely accepted is given by Haynes et al. (1979). They state compliance is 'the extent to which a person's behavior (in terms of taking medications, following diets, or executing other lifestyle changes) coincides with medical or health advice'. Noncompliance is when a person's behavior does not coincide with medical or health advice. Hussey and Gilliland (1989) describe two types of noncompliance: 1) Inadequate understanding of the disease or condition being treated (unintentional noncompliance), and 2) A conscious choice by the patient to find another method of treatment or to not comply (intentional noncompliance). Jay et al. (1984) described several types of groups including; patients who take their medications but not as instructed, patients who miss several doses of medication and complete failure to take the prescribed medication. Most

studies involving compliance have focused either on adults, or both children and adults. Very few studies have focused specifically on children or adolescents. In a review of the literature by Jay et al. (1984), in nine reported studies of noncompliance relating only to children, the average rate of compliance was fifty-four percent. These studies involved both clinic settings and physician's offices, and included determination of long-term and short-term compliance. The studies also measured compliance with both medication and routine health counseling. From that information the authors concluded that the figure of fifty-four percent encompasses too much diversity to be of value except to indicate that compliance in children is generally low.

In another comprehensive review of the literature, Haynes (1979) reported that despite moderate variation, rates of compliance with different long-term medication regimens for different illnesses in different settings tend to converge to approximately fifty percent. Exceptions appear in the form of higher rates when based upon either the reports of clinicians or self-reporting by patients. Others have examined compliance rates with certain drug regimens such as antacid therapy, penicillin prophylaxis, phenytoin and isoniazid therapy, and have reported compliance rates varying from forty-six to sixty-two percent (Ruffalo 1985). More recent studies evaluating

treatment adherence in patients with cystic fibrosis and asthma have also reported rates of approximately fifty percent (Modi et al. 2006, Horne and Weinman 1999).

In examining these compliance rates, it is important to take into consideration the distribution of individual patient's compliance rates. Gordis et al (1979) provided data for which a frequency distribution of compliance rates could be constructed for children on long-term oral penicillin prophylaxis for rheumatic fever. The compliance distribution is roughly U-shaped, with one-third of the patients taking virtually no medications, one-third almost all medications, and the rest scattered in between. A similar pattern was found by Haynes (1980, 1976) among steelworkers on antihypertensive drugs. These types of distributions are much different than the statistically normal, bell-shaped distribution curves.

The measurement of compliance in the medical literature is broken down into direct and indirect measures. For direct measurement, analysis of body fluids to determine presence, absence, or actual levels of the prescribed medication provides the most objective measure. Because of the high cost associated with routine analysis of body fluids to monitor ongoing compliance, this technique is impractical. Indirect measures include pill counts, self-reporting, physician assessment, and outcome assessment (Jay et al. 1984).

The orthodontic phase of retention can be thought of as similar to the medical model of adherence to a prescribed drug regimen. The wearing of removable orthodontic retainers involves adolescent compliance to a prescribed regimen without regular doctor visits and evaluation. Factors relating to adherence of therapeutic regimens, and wearing of removable orthodontic appliances, often are complex. In an adolescent, wearing retainers may disrupt established routines or interfere with social activities. Compliance during this period presents its own set of challenges. Changes in parental influence, in either promoting adaptive behaviors or providing standards against which to rebel, along with increasing importance of peers and developmental issues related to emerging adult identity, may encourage resistance in some and greater maturity in others, to follow the health care recommendations (Albino et al. 1991).

Compliance Assessment in Orthodontics

Direct Measures of Assessment

The orthodontic literature examining patient compliance focuses on behavioral and personality characteristics of the patient in regards to treatment outcomes. Multiple theories, models, and analyses to predict orthodontic patient compliance have been proposed (Allan and Hodgson 1968, Bartsch et al. 1993, Bos et al. 2005, Bos et al 2005, Cucalon and Smith 1990, Egolf

et al. 1990, El Mangoury 1981, Gabriel 1965, Mehra et al. 1998, Nanda and Kieri 1992, Sergl et al. 1992, Southard et al. 1991, Weiss and Eiser 1977, Woolass et al. 1988), yet very few studies have attempted to directly assess patient compliance rates. Previous reports in the literature attempting to directly measure compliance have focused on removable appliances such as headgear and oral sleep apnea appliances (Banks and Reid 1987, Brandao et al. 2006, Clemmer and Hayes 1979, Cole 2002, Cureton et al. 2003, Dort and Hussein 2004, Swetlik 1978). One limitation to these studies is they have typically evaluated compliance six to twelve months after the onset of treatment, and have not assessed long-term cooperation throughout the full course of treatment. This is important because multiple studies have shown an overall decrease in patient cooperation towards the end of treatment, when the treatment is of a long duration (Albino et al. 1991, Haynes 1976, Haynes 1979).

Cole (2002) evaluated the accuracy of patient reporting via the use of a headgear timer and patients self-reporting of hours worn. He evaluated compliance in terms of the accuracy levels at which the subjects reported their headgear usage. He found that the patients' average accuracy as a group was seventy-four percent. When analyzed further, the data showed two different groups, a good compliance group with an average accuracy level of ninety-three percent, and a poor compliance group which

averaged thirty-four percent. This study seems to indicate that in assessing compliance, patients could be divided into two groups; a good reporting group in which you would get over ninety percent accurate reporting, and a poor compliance group in which the reporting of wear will be overestimated by about three times. Some limitations of this study was a small sample size of sixteen patients and the author did not evaluate the accuracy of the headgear timer itself over an extended period of wear in a patient. A sham headgear was used to test the accuracy of the device, they indicated the timing device was placed under tension for a known number of hours and compared that with the number of hours recorded by the device. They indicated it was over ninety-nine percent accurate, however it was not retested at any point during the six month duration of the study. The compliance level values were only total headgear wear reported, compared to the amount of headgear wear measured by the headgear timer. Age and gender differences were not evaluated.

Cureton et al. (1993) focused their study on the accuracy of clinical versus quantitative assessment of headgear compliance. Twenty-eight patients were asked to wear the headgear twelve hours per day and were informed they were being monitored by a timer, and would be evaluated by clinicians at future visits. Clinicians then evaluated each patient at

specific follow up times for three appointments, and gave their opinion on compliance of headgear wear. This clinical (subjective) assessment of headgear compliance was compared to both reported use by the patient and the values obtained from a headgear timer. It was found that patients ten to twelve years of age wore their headgear more than those twelve to fourteen years of age, who wore their headgear more than those older than sixteen. The fourteen to sixteen year age range was the least compliant. He also found no difference in the amount of headgear wear between males and females. The overall compliance rate as evaluated from the headgear timer was approximately fifty-eight percent and the data tends to indicate age may be a factor when assessing compliance in orthodontics.

Brandao et al. (2006) conducted a pilot study of twenty-one patients who were initially given headgear with a timing device attached, but did not know the timer was present. They were instructed to wear the headgear fourteen hours per day, and record the amount of hours per day they wore it. The evaluation was done in two stages; the second stage beginning seventy days after the headgear was placed. During the initial seventy day period the patients were not told the headgear contained an electronic timing module. The modules were read at every two week visit and amount of wear recorded. After the initial seventy day period, the patients were informed that they were

being monitored with the timer. Readings continued to be taken every two weeks to observe the compliance rate changes. Reported headgear compliance rates were fifty-seven percent when patients were unaware they were being monitored and sixty-three percent when they were aware. It was also found that younger patients were more compliant than older ones, and boys were more compliant than girls, which is in contrast to Cureton et al.'s findings.

Bartsch et al. (1993) used psychologic inventories along with a microelectronic timing device to evaluate compliance rates of removable appliance wear, and associated variables. Their sample consisted of seventy-seven patients ranging in age from nine to fifteen years who received bionators at some point in treatment. The microelectronic timing device consisted of a magnet fixed to a six year molar, which activated a sensor system composed of quartz watch circuits in the bionator. When the appliance was placed in the mouth, the sensor was activated and the time recorded. These values were recorded at subsequent treatment appointments every three to four weeks. The difference between the actual time elapsed and the time elapsed as measured by the timing devices represented the total time worn during the observation period. The mean daily hours of wear was then calculated at each interval. Compliance was calculated as the mean actual hours of daily wear relative to

the orthodontist's requirement stated in hours per day. The number of observations averaged three point four times per patient. The actual compliance rate averaged fifty-seven percent, which corresponded to a mean daily wear of eight point seven hours. Only three of the seventy-seven patients were found to be overcompliers, with a maximum compliance rate of one hundred ten percent. Overcompliance meant the hours of daily wear by the patient was greater than the hours of wear instructed by the orthodontist.

With the duration of treatment partialed out, they found no linear relationship between age and the actual compliance rate. Using the partial correlation analysis they found that the relationship between age and compliance was of a complex, nonlinear nature and duration of treatment was clearly associated with a monotonous decay of compliance. They stated that appliance wear becomes more of a problem up to the time of commencing puberty, no matter how long the patient had been receiving treatment. Using the point-biserial correlation they found no gender effect on compliance, even thought the orthodontist's perceptions of compliance was more favorable in girls.

One of the limitations of the study was a relatively small sample size in relation to the amount of variables evaluated. Compliance was also determined as the mean percentage of

fulfillment over a certain period of time. This meant that no information regarding the regularity of the continuity of wear could be assessed. The values may have been affected by a period of overcompliance close to the next reading appointment, making the average wear look ideal.

Dort and Hussein (2004) examined compliance in patients using removable sleep apnea appliances. Questionnaires regarding patient use of the appliances were mailed to one hundred ten patients who were four months post-titration. The range of time since titration ranged from four to forty eight months. The titration point varied depending on whether the appliance was adjustable or non-adjustable. If the appliance was adjustable, then titration was considered to be when the appliance had been advanced to its most effective position as determined by the patients' symptom relief, and a follow-up study. If the appliance was non-adjustable, then titration was considered to be when the appliance was reportedly worn of a minimum of four hours each night. Responses were obtained from seventy-seven patients, and the overall response rate was seventy percent. These patients were then categorized into three groups: 1) Nonresponders (NR), 2) Noncompliant responders (NCR), and 3) Compliant responders (CR). Compliance meant that they were still wearing their appliances. She found that of the one hundred ten patients, forty-four were still wearing the

appliance (CR), thirty three had stopped using the appliance (NCR) and thirty three did not respond (NR). This gave an overall compliance rate of forty percent if they assumed the non-responders were non-compliant. If you do not make this assumption and simply looked at the responders, this gives you a compliance rate of fifty-seven percent.

These compliance rates are slightly lower than a previous study in the field of oral sleep apnea appliances. Walker-Engstrom et al. (2002) evaluated the effects of treatment with a dental appliance on forty-five patients with mild-to-moderate obstructive sleep apnea. These patients were followed up for four years, with visits at two weeks and three, six, twelve, and forty-eight months following intervention. Compliance was defined as whether or not the patient was still using the appliance at the time of evaluation.

At the one year follow up, thirty-seven patients were still using the appliance, for an eighty-two percent compliance rate. Of the thirty-seven patients who completed the one year follow up, five of these withdrew between the one and four year follow up. Of the remaining thirty-two patients, four chose a surgical procedure to correct the problem giving twenty-eight patients still using the compliance at the four year evaluation. The compliance rate was then sixty-two percent after four years.

In the previously described headgear studies it was found that patients generally overestimate or over report their removable appliance wearing time, indicating they are fairly non-compliant with this aspect of treatment. This does not necessarily mean that patients will be non-compliant with their prescribed retention protocol.

Gross and Sampson (1998) discuss how patients can be selective in which parts of orthodontic treatment they want to comply with. Orthodontic patients who have been shown to have a compliance rate of approximately sixty percent may have much higher compliance rates with retainers. In studies using the headgear timer it is also important to note that the reliability of these timing devices has been questioned in the literature. Jacobs (2002) tested 15 headgear timers in which the readings ranged from 52 percent to 140 percent of the actual value. She concluded "treatment decisions and research activities based solely on the information gained from the timing headgear should be guarded." Banks and Reid (1987) tested thirteen headgear timing devices in which only four of the thirteen produced mean timing accuracy values exceeding ninety percent. The other nine devices all produced mean values for accuracy below thirty percent. These studies indicate that the use of headgear timing devices may not be valid in recording patient wear.

Indirect measures of assessment

The other main area of focus in the investigation of orthodontic patient compliance is the psychological assessment of patients. This approach attempts the use of models, theories and questionnaires to correlate personality characteristics and behaviors of the patient with treatment compliance.

El-Mangoury (1981) evaluated a sample of seventy-seven orthodontic patients mid-treatment and administered multiple tests including the El-Mangoury psychological test, an achievement and affiliation motivation test and an attribution motivation test. These tests were followed by an orthodontic and periodontal examination to measure headgear and elastic wear, oral hygiene and multiple other factors. Headgear wear was determined clinically by examination of anchorage maintenance and tooth mobility. Anchorage maintenance was defined as resistance of anchor teeth to mesial movement, and classified as; excellent maintenance, moderate maintenance, pseudo-loss, and severe anchorage loss. Amount of tooth movement and length of time for retraction determined elastic wear. These were classified as; rapid retraction, moderate retraction, slow retraction, and no retraction.

For the analyses of data, excellent headgear wear and moderate wear were grouped into a good compliance category, while the pseudo-loss and severe anchorage were grouped into poor compliance. For elastic wear, rapid and moderate

retraction was grouped into good compliance, while slow and no retraction into poor compliance. Comparisons were then made between the recorded compliance levels and the predicted compliance levels.

Approximately seventy percent of patients were judged to have good compliance with headgear wear, with the other thirty percent poor compliance. Seventy-seven percent of patients were judged to be good compliers with elastic wear, while the other twenty-three percent poor compliers. The relationship of age and gender to compliance was not analyzed in this study. One important point that was stressed was orthodontic cooperation is composed of a complex, non-linear structure. This meant that a patient who is compliant with one aspect of treatment does not have to be good in all aspects of treatment and vice versa. This is in agreement with Gross and Sampson's view (Gross and Sampson 1998).

Cucalon and Smith (1990) evaluated two-hundred fifty-two adolescent orthodontic patients and categorized them into good, fair, or poor compliance categories. The criteria used to define the compliance categories included: oral hygiene, appliance maintenance and care, elastic and/or headgear wear, and missing/late to orthodontic appointments. Oral hygiene was defined as consistently clean appliances with minimal gingivitis. Appliance maintenance referred to absence of broken

or distorted appliances and few loose bands or brackets. Elastic and headgear wear referred to continuous wear of each item as directed by orthodontist, and number of missed and late appointments also evaluated. The patients were evaluated in regards to these categories and assigned to the above compliance categories.

After categorization of the patients, three questionnaires were administered: (1) Comprehensive Personal Assessment System: Self-Report Investory, by Brown (2) The Adolescent Alienation Index, by Heussenstamm and (3) The Home Index, by Gough. These questionnaires measured different aspects of the adolescent's personality and environment. In addition to the personality and environmental characteristics assessed, the authors also evaluated the effects of age, race and sex in predicting patient compliance. They found that for age, the division of subjects into eleven to fourteen years and fifteen to seventeen years old categories did not show a significant difference. The racial distribution of patients into Black, Asian and Caucasian did not show a significant difference either. However, the most significant variable, including all psychological test scores, was the gender of the patient. While the sample included one hundred thirty-six females and one hundred sixteen males, the good complier group was sixty-five percent female and the poor compliers were sixty-three percent male.

Albino et al. (1991) evaluated eighteen boys and twenty-one girls between the ages of eleven and fourteen who sought orthodontic treatment. Prior to beginning treatment each subject completed a structured interview that included a battery of psychosocial and orthodontic-specific measures. These measures were chosen based on previous associations with adolescent cooperation.

Eight to ten months into treatment, the orthodontic assistant working with each child completed a questionnaire designed to assess cooperation with treatment (Time 1). Long term cooperation was assessed at completion of active treatment (Time 2). Cooperation at the two time points was then assessed in relation to scores on the twenty-two psychosocial and thirteen orthodontic specific variables obtained prior to treatment via the interviews. They found a significant decrease in cooperation scores between the earlier assessments, eight to ten months after treatment onset (Time 1), and at completion of active treatment (Time 2). They noted that the decrease in cooperation did not appear to be due either to length of treatment, or to age of study participants. The psychological and behavioral factors predicting cooperation within the first ten months of treatment were different than those at the end of treatment.

The authors concluded that age and duration of treatment did not affect cooperation scores directly. However, cooperation due to age and/or treatment duration may be related to psychosocial variables which change over time. It was also discussed that when sustained cooperation over long periods of time is required, more is demanded on the part of the patient. Some adolescents may begin to feel that treatment has taken so long that their behavior could not have influenced of will no longer affect its outcome, and they may subsequently stop complying with regimens that are difficult to maintain.

Evaluation of age and gender differences on compliance is frequently reported in the literature, although it may not be the focus of the study. In summarizing the available orthodontic literature regarding compliance, four studies have found age differences to be a factor (Allan and Hodgson 1968, Colenary and Gabriel 1977, Weiss and Eiser 1977, Kreit et al. 1978) while five have found it to make no difference (Cucalon and Smith 1990, Clemmer and Hayes 1979, Albino et al. 1991, Swetlik 1978, Nanda and Kieri 1992). In the four studies showing a difference, younger patients have been found to be the most compliant with a decrease as patients get older. Evaluating the effect of gender, four studies have reported females to be more compliant than males (Cucalon and Smith 1990, Starnbach and Kaplan 1975, Kreit et al. 1978, Clemmer and Hayes

1979) while five have shown no difference (Allan and Hodgson 1968, Albino et al. 1991, Swetlik 1978, Nanda and Kieri 1992, Mehra et al. 1998). It is interesting to note that of the ten studies showing no difference in either age or gender, four of these have shown no difference in both (Albino et al. 1991, Swetlik 1978, Nanda and Kieri 1992, Mehra et al. 1998). These agreements may be related to the method of assessment and sample size of the studies. Cultural and geographical biases could also have affected the results.

An important point to keep in mind is the dropout rate for patients in any compliance study. One reason for dropouts may be the complete discontinuation of retainer wear by the patient, which is the most extreme form of non-compliance. Lindauer and Shoff (1998) is the only study evaluating retainers that has reported dropouts. Their study compared the effectiveness of Essix and Hawley retainers in maintaining orthodontic corrections. The study started with twenty-eight patients in each group. The patients were instructed to wear their mandibular essix retainers full-time and their maxillary essix retainers half-time for the first four weeks, and both retainers at night only for the last five months. Patients were given two sets of retainers for each arch in this group, the second set serving as a replacement in case the other was lost or broken. The Hawley retainer group was instructed to wear both maxillary

and mandibular appliances full-time for the first three months, and both retainers at night only for the last three months. These patients were to return after six months of active retention for evaluation and occlusal measurement via study models.

Sixteen of the fifty-six patients in the previous study were eventually eliminated. Five patients in the essix group and two in the Hawley group lost their retainers and did not wear them for a week. Four patients from each group moved out of the area or did not show up for their six-month appointment. One Hawley patient requested a fixed retainer instead of the removable appliance. A dropout rate of twenty-nine percent occurred, with eleven percent of the patients losing and discontinuing retainer wear after only one week. The authors also noted that even though they did not need to remake any retainers during the six month study period, several did become perforated or cracked over the next six to twelve months and needed to be replaced.

Self-reporting surveys and use of the World Wide Web

Even though patient self-reporting is the most common method of assessment in compliance research, it has limitations and biases associated with it, most predictably reporting biases. Patients may overestimate the amount of compliance for fear that admitting to noncompliance may lead to adverse

judgments or penalties (Horne and Weinman 1999). Because reports of non-adherence may be more accurate than reports of adherence, self-report tends to underestimate the true extent of nonadherence by approximately twenty percent (Haynes 1980). However, self-reporting has several advantages. Most other measures of adherence require that the patient is given prior warning of monitoring and this may constitute an intervention that may influence compliance behavior. Self-reporting can give you a convenient "spot check" estimate of compliance behavior (Horne and Weinman 1999). By using a survey with language that is simple and non-threatening, and assuring the patient that responses are anonymous and confidential, attempts can be made to relieve any social pressures that could possibly affect the outcomes.

The use of the world-wide-web as an adjunct tool for self-reporting surveys is a new concept that is evolving fast. Web surveys are less costly and more convenient for researchers, present a more attractive multimedia platform, and perhaps improve privacy to respondents (Bos et al. 2005). There are few studies comparing internet surveys with traditional paper surveys for the collection of self-reported data, but it appears that internet surveys are not only comparable in almost all aspects, but may lead to higher reporting rates of sensitive and

stigmatized data (Link and Mokdad 2005, McCabe 2004, Wong et al. 2006).

Wang et al. (2005) assessed the feasibility of collecting health risk behavior data from undergraduate students using both paper and web-based self-administered questionnaires (SAQ). In particular, it focused on stigmatized behavior such as substance abuse and illicit drug use. A stratified, two-stage, cluster sampling procedure was used for the selection of participants from three types of schools in Taipei City and County, Japan: Senior high, Junior high, and vocational schools. The two-thousand sixty eight eligible participants were then randomized to receive either a paper survey or a web based survey. The overall response rate for the study was ninety three percent, which consisted of ninety percent for web SAQ and ninety-five percent for paper SAQ.

The authors found no statistical differences for demographics, response rates, item completion and item completion errors. The authors did show that the web SAQ was more likely than the paper SAQ to elicit higher prevalence of substance abuse including alcohol and tobacco use. For illicit drug use, there was tendency of higher prevalence estimates in the web SAQ but only one of four drug types reached statistical significance. The authors concluded the web group participants, especially boys and students of junior high and vocational

schools, were more inclined to reveal potentially embarrassing or sensitive information regarding substance abuse than were participants in the traditional paper group.

Fleming and Bowden(2008) compared results obtained from a travel cost questionnaire of visitors to Fraser Island, Australia, that was conducted using two alternate survey administration modes; conventional mail and web-based. It was also found that response rates and the socio-demographic make-up of respondents to the two survey modes were not statistically different.

Data is sparse, if non-existent, on removable retainer compliance following orthodontic treatment. Therefore, a first step is the investigation of how much are patients actually wearing their retainers? Are they compliant with the retention protocols established by their orthodontist? The purpose of this study is to attempt to determine the duration in hours per day, and nights per week, patients are actually wearing their retainers in the two years following active orthodontic treatment. Both paper and internet-based surveys are used in an attempt to answer these questions.

Assessing retainer wear and compliance in the first two years following active treatment using a survey based instrument

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Objectives: The purpose of this descriptive study was to estimate retainer wear and compliance among orthodontic patients in the two years following active orthodontic treatment. **Method**s: A random sample of 1200 orthodontic patients from 4 offices was chosen. Data were collected by a self-administered questionnaire that consisted of six items: type of retainer prescribed, age, gender, length of time since debond, and the hours per day and nights per week that patients were wearing their retainers. Responses were solicited by mail or the internet. Data were gathered on a categorical scale and analyzed using SPSS®. **Results**: Overall response rate was 36% during a 6 week period. In the first three months after debond, 60% of patients are wearing their retainers more than 10 hours during a 24 hour cycle and 69% were wearing the retainers every night. At 19-24 months after debond, 19% of patients were not wearing retainers at all and 81% of patients are wearing their retainers at least one night per week. In assessing compliance, 69%, 76%, 55%, 62%, 45% and 45% were compliant during the 0-3, 4-6, 7-9, 10-12, 13-18, and 19-24 month categories respectively. Age, gender and type of retainer did not influence retainer wear or compliance in the sample. **Conclusions**: The majority of patients continue to wear their retainers at least one night per week with compliance rates tending to decrease as defined in our sample. It is, encouraging to note that 81% of the patient's in this sample would largely maintain their orthodontic result.

Introduction:

Retention of orthodontic results is a critical component of successful long-term treatment. The retention phase is almost entirely patient dependent, as most orthodontists prescribe removable appliances[1]. A study by Valiathan and Hughes surveying 2000 orthodontists across the United States showed that most orthodontists prescribe less than nine months of full-time wear of removable retainers and thereafter advice part-time, but lifelong wear[1]. The authors also reported a greater percentage of orthodontists prescribing Hawley retainers recommend a longer duration of full-time wear (3-9 months) compared to clear thermoplastic retainers (3 months or less). The most common part-time wear schedule was 8 hours a day, and eighty four percent of orthodontists who prescribed removable retainers recommended lifetime retainer wear. While we may now better understand the prescriptions most commonly advised by our colleagues, are patients complying with retainer wear and can we predict their behavior?

Hichens (2007) performed a randomized, controlled, clinical trial set in a single orthodontist's office to evaluate patient satisfaction between the Hawley and the Vacuum Formed Retainer (VFR) [2]. The study included 201 patients receiving VFR's and 196 receiving Hawley retainers. Patients were instructed to wear both the VFR's and Hawley retainers twenty-four hours a day for the first three months and 12 hours per day from 3-6 months following treatment. The majority of subjects preferred VFR's with 85% of Hawley's and 95% of the VFR group indicating that they wear the retainers. The study was not designed to test compliance and did not indicate the amount the retainers were being used per day or week.

In assessing compliance in the orthodontic literature, specific studies have found age to be related[3-6] while others have not [7-11], with compliance rates typically decreasing with age.

Similarly, studies have reported females to be more compliant than males[5,7,8,13], while others have shown no difference [3,9-12].

In the medical literature on patient behavior, it is not uncommon to find a third of patients never complying with their medications regardless of if the study was on children advised long-term oral penicillin use for rheumatic fever or antihypertensive drugs[14-15] in steelworkers.

Orthodontic retention is a complex issue. The age of the patient, retainer design, parental influence, orthodontist's prescription, fear or disregard of relapse, are all factors that are likely to influence patient behavior. Changes in parental influence, in either promoting adaptive behaviors or providing standards against which to rebel, along with increasing importance of peers and developmental issues related to emerging adult identity, may encourage resistance in some and greater maturity in others, to follow the health care recommendations[16].

The purpose of our descriptive study was to identify patient behaviors as it pertained to the use of their retainers. Specifically, we attempted to estimate the number of hours per day and week that patients are wearing their retainers in the first 2 years following active orthodontic treatment, and if that agreed with the prescription advised by their respective orthodontist.

Materials and Methods:

The procedures and protocols for this study were approved by the Institutional Review Board at a major university and established graduate orthodontic program in the Midwest. Following a critical review of the literature, the initial survey instrument was designed with the "tailored design method" [17]. The questionnaire was pilot tested on a group of eleven retention patients in the Department of Orthodontics. The responses were reviewed and minor revisions made to form a preliminary survey instrument. The preliminary survey was converted to an electronic form and hosted on SurveyMonkey.com. The electronic version was once again tested

on eleven different patients and revised as needed, to arrive at the final survey instrument. The final survey consisted of six questions, four to characterize our sample and two to help identify how much retainers are being worn in the first two years following active treatment.

Four private orthodontic offices in the area consented to participate in the study. The questionnaire with a cover letter explaining the purpose of the study was mailed along with a postage paid self addressed envelope to 1200 randomly selected patients, from four separate orthodontic offices. All patients had their orthodontic braces removed during a period between January 15th, 2006 and January 15th, 2008. The offices were selected based on their respective retention protocols, in an effort to best match their protocols with to the most commonly prescribed retention protocols in the United States[1]. The number of patients debonded in the last two years in the four offices, and the common retention ptotocols prescribed were:

1. Office 1: 663 patients; maxillary and mandibular trutains prescribed 24 hour a day for 6 weeks, 12 hrs for the next 3 months, followed by nighttime wear starting from 4.5 months for the remaining 19.5 months.
2. Office 2; 1,015 patients. Maxillary Trutain and Hawley (patient chooses which to wear) with Fixed Mandibular 3-3. Prescribed 24 hour wear for 3 months, with nighttime (sleeping) wear from 4-24 months.
3. Office 3; 582 patients. Maxillary Trutain with Mandibular fixed 3-3. Prescribed 10-15 hour wear for three months, with nighttime (sleeping) wear from 4-24 months.
4. Office 4; 387 patients. Maxillary Trutains for the first 2 weeks, followed by a Maxillary Hawley, and Mandibular Fixed 3-3. Prescribed 24 hour wear for 6 months with nighttime (sleeping) wear from 7-24 months.

** All offices instructed patients on continued nighttime wear for life after being dismissed as retention patients following two years observation.

In order to attain statistical significance, a total of 370 responses were required; the estimate was based on the total of 2,638 patients, a 95% confidence interval, and a ± 5 percent sampling error[18]. No patients debonded during the stipulated time frame were excluded, giving all patients an equal opportunity to participate. Anticipating a 33 % response rate, random samples of 300 patients from each office were selected, for a total of 1,200. Surveys were mailed to each patient from their respective orthodontist's office following the approved protocols. The envelopes contained a cover letter from the respective orthodontist, a one page letter from the investigators describing the project, the two page survey, and a postage-paid, self addressed envelope. Participants were also given the option of completing the survey online by proving them a link and unique identification number in the survey they received. The time frame to collect responses was six weeks from the date of mailing. After six weeks, hard-copy responses were manually entered and internet responses were recorded as categorical data using Microsoft Excel 2007 spreadsheets (Microsoft Corporation – Redmond, WA). Partially completed responses were excluded. Response rate was calculated as the number of surveys returned divided by the number of surveys that were sent out and not returned as undeliverable.

For reliability, double data entry was performed by manually entering age, gender, and lengths of time since debond, from the responding patients' treatment files, into a separate Excel spreadsheet. This secondary spreadsheet was cross-referenced with the initial spreadsheet to evaluate reliability. Any errors found were further assessed, recorded, and manually corrected. Microsoft Excel 2007 was used for the descriptive statistics and SPSS 16 was used to calculate frequencies, percentages and run chi-square tests to detect differences between offices. The chi-

square tests assessed the differences in compliance levels between/among the the four offices and the following variables; age gender, the type of retainer, and length of time since debond. Compliance was determined by adherence to the "lowest common denominator" among office retention protocols.

A logistic regression analysis was performed with non-compliance as the dependent variable and the offices, type of retainers, gender, and length of time since debond as independent variables. The significance level (alpha) for the chi-square tests and logistic regression analyses was set at ≤ 0.05.

RESULTS:

During the six weeks of data collection, 428 (36% overall) completed surveys were received out of the 1200 mailed surveys. We received 110 responses (25.7%) from Office 1, 93 responses (21.7%) from Office 2, 122 responses (28.5%) from Office 3, and 103 responses (24.1%) from Office 4. Of the 428 respondents, 396 chose to complete the paper survey mailed to them and 32 chose to complete the web-based survey. Six surveys were excluded from the final results, five paper surveys due to incongruent answers, and one web-based survey due to the ID number being incorrect. In all, there were 2598 individual responses entered into Microsoft Excel and 33 mistakes corrected after manual double data entry, representing .012% of responses. Sixty percent of respondents were female, and forty percent male. No surveys were returned as undeliverable.

Table I describes the characteristics of our sample; age, gender, length of time since debond, type of maxillary and mandibular retainers and the number of responses from each office. The response rate from the offices ranged from 21.7% to 28.5%. Only ten percent of respondents were in the thirteen and younger category and the majority were fifteen year olds.

The range of responses for length of time since debonds were 12% to 22%, with the least responses in the seven to nine month category, and the largest coming from the nineteen to twenty-four months category. The most common removable retainers in both the maxillary and mandible were the trutains; 66.4% and 28% respectively.

Chi-square tests were performed to detect differences in compliance among the four offices, and differences in retainer wear among the offices in relation to length of time since debond. Only one significant difference in compliance levels was found among the four offices: between Office 1 and Office 3. Significant differences were found in compliance levels in relation to length of time since debond at the 0-3 month, 4-6 month, and 13-18 month time points ($p=.002$, $p=.000$, $p=.015$ respectively). The 7-9 month, 10-12 month and 19-24 month timpoints did not show any significant differences ($p=.431$, $p=.467$, $p=.240$ respectively). These results are represented in Tables II, III, and IV. Logistic regression analysis did not reveal any significant association between non-compliance levels and the independent variables; age, gender, type of retainer worn, length of time since debond, or office.

Figures I and II evaluate the nights per week, and hours per day, patients are wearing their retainer compared to length of times since debond. In the first 3 months following treatment, 27% of patients wore their retainers 16-24 hours, 36% wore them less than 10 hours per day, and 4% did not wear them at all. From 19-24 months after debond, 19% were not wearing retainers at all during the day, 67% were wearing them less than 10 hours, and 11% was still wearing the retainers 10-15 hours

Figure III evaluates the compliance of patients in nightly wear, at three separate time points. Compliance was determined by adherence to the "lowest common denominator" among office retention protocols. All offices were united in their recommendation of night time wear

for the entire two year period and therefore patients not wearing their retainers each night were considered non-compliant. Compliance rates varied from 69% in the first 3 months, to 55% at 7-9 months, and 45% at 19-24 months after debond.

DISCUSSION:

Our study revealed the majority of orthodontic patients continue to wear their retainers two years after orthodontic treatment. Only four percent of patients reported not wearing their retainers in the first three months following debond and this number increases steadily in the first nine months, with a larger increase around one year. We found no difference in retainer wear due to age, gender, or type of retainer worn. These results are in agreement with previous studies evaluating gender and other removable appliances[9-12]. These findings also agree with previous studies showing either no difference in compliance due to age, or younger patients being more compliant than older patients[3-11]. No previous studies have evaluated compliance and type of retainer worn.

Hichens found that through the use of a patient satisfaction questionnaire, most people showed a preference for trutains more than Hawley retainers[2]. In office 2, patients are given both a maxillary Trutain and maxillary Hawley retainer and given the choice to wear either. Although we did not specifically evaluate patient satisfaction with the different types of retainers, we did note that given a choice, there is virtually no difference in preference of retainer with 54% wearing their Hawley retainer, while 46% indicated wearing their Trutain.

From debond through the first 2 years, all four offices recommended every night retainer wear for 2 years. Our estimates of compliance based on this standard were 69% complied in the first 3 months, 55% between the 7th-9th months, and 45% from 19-24 months. These results follow the medical model of both decreasing levels of patient cooperation towards the end of

treatment, when treatment is of a long duration[9,19], and that rates of compliance with different long-term medication regimens for different illnesses in different settings tending to converge to approximately 50%[20-22].

One may argue that the decline in nightly wear is due to the rigid definition chosen for compliance by the authors, namely wearing retainers every night for 2 years. We therefore evaluated the percentage of patients wearing their retainers 1-6 nights per week and found 27%, 33%, and 36% were doing so at the 0-3 months, 7-9 months, and 19-24 months, respectively. Although these patients were included in the non-compliant category based on the criterion set, they may well be wearing their retainers enough to maintain the teeth in their corrected positions. When you combine these 2 categories, there were 96%, 88%, and 81% of patients wearing retainers at least one night per week in the 0-3 month, 7-9 month, and 19-24 month categories respectively.

Despite orthodontists prescribing full time wear of the retainers for the first three months, approximately one-third of respondents were non-compliant. There is an increase in the number of non-compliant patients by the end of two years, but eighty percent of patients are still wearing their retainers at least one night per week. This may be due to the age range of the respondents with most teenagers being more self-conscious and therefore desirous of wanting to maintain the results achieved in treatment.

In evaluating differences between the offices in regards to compliance among the four offices, we did find differences at the 0-3 month, 4-6 month, and 13-18 month time points. This seems to indicate that patients are not wearing retainers for the amount of time as instructed by the orthodontist, but rather of their own choosing. At the 0-3 month, and 4-6 month time points, the amount of retainer wear among the offices was similar regardless of retention protocol. Even

though Office 4 instructs full time wear of retainers from 0-6 months, and Office 3 instructs 10-15 hours wear for the first three months, patients appear to be willing to wear their retainer at some point during the day, but not as prescribed. At the six month time point, all offices are at a protocol of nighttime wear only, every night. With all retention protocols being the same, there were no differences in compliance levels at the 7-9 month and 10-12 month time points.

Strengths of this study are the systematic method used to design the survey, the random sample used, and the good response rate. Weaknesses of our effort were that we were unable to characterize the non-responders based on our institutional protocol. Also, in assessing self reported data, there may be a tendency to over report wearing their retainer[23]. To the best of our knowledge, this is the first study of its kind evaluating patient behavior in the first two years following the removal of fixed appliances.

CONCLUSIONS

Within the first three months of fixed appliances being removed, 4% of our sample was not wearing retainers and by the end of the first year this number increased to 7%. Nearly 20% of the sample was not wearing retainers by the end of two years of the retention phase. However, the vast majority continue to wear their retainer less than 10 hours per day, every night of the week. From nineteen to twenty four months after debond, 45% of patients are wearing their retainers every night, with 81% of patients wearing retainers at least one night per week. Compliance, as defined as daily nighttime wear, steadily decreased from around 70% in the first three months to 45% percent from nineteen to twenty four months after debond.

ACKNOWLEDGEMENTS

The authors would like to thank the staff and four orthodontists for their participation and the patients who responded.

Table I – Frequency and Percent distribution of Characteristic Variables among Respondents

Variables	N	%
# of Respondents:		
• Office 1	110	25.7%
• Office 2	93	21.7%
• Office 3	122	28.5%
• Office 4	103	24.1%
Age:		
• ≤13	42	9.8%
• 14	53	12.4%
• 15	106	24.8%
• 16	75	17.5%
• 17	66	15.4%
• ≥18	86	20.1%
Length of time since debond:		
• 0-3 months	75	17.5%
• 4-6 months	70	16.4%
• 7-9 months	51	11.9%
• 10-12 months	53	12.4%
• 13-18 months	85	19.9%
• 19-24 months	94	22.0%
Maxillary Retainer Type:		
• Trutain	284	66.4%
• Hawley	138	32.2%
• Bonded	1	.2%
• Other	5	1.2%
Mandibular Retainer Type:		
• Trutain	120	28.0%
• Hawley	14	3.3%
• Bonded	271	63.3%
• Other	23	5.4%

Table II –Compliance levels among the four offices from 0-3 months

Variables	Compliant	Non-Compliant	Total
Office 1	2	23	25
Office 2	7	10	17
Office 3	5	13	18
Office 4	23	51	14
Total	23	51	74

x2=14.324
df = 3
p= .002

Table III –Compliance levels among the four offices from 4-6 months

Variables	Compliant	Non-Compliant	Total
Office 1	7	10	17
Office 2	17	1	18
Office 3	16	1	17
Office 4	6	13	19
Total	46	25	71

x2=26.689
df = 3
p= .000*

Table IV –Compliance levels among the four offices from 13-18 months

Variables	Compliant	Non-Compliant	Total
Office 1	21	2	23
Office 2	7	8	15
Office 3	20	6	26
Office 4	17	4	21
Total	65	20	85

x2=10.455
df = 3
p= .015

Figure 1: Hours per day patients are wearing their retainers by length of time since debond

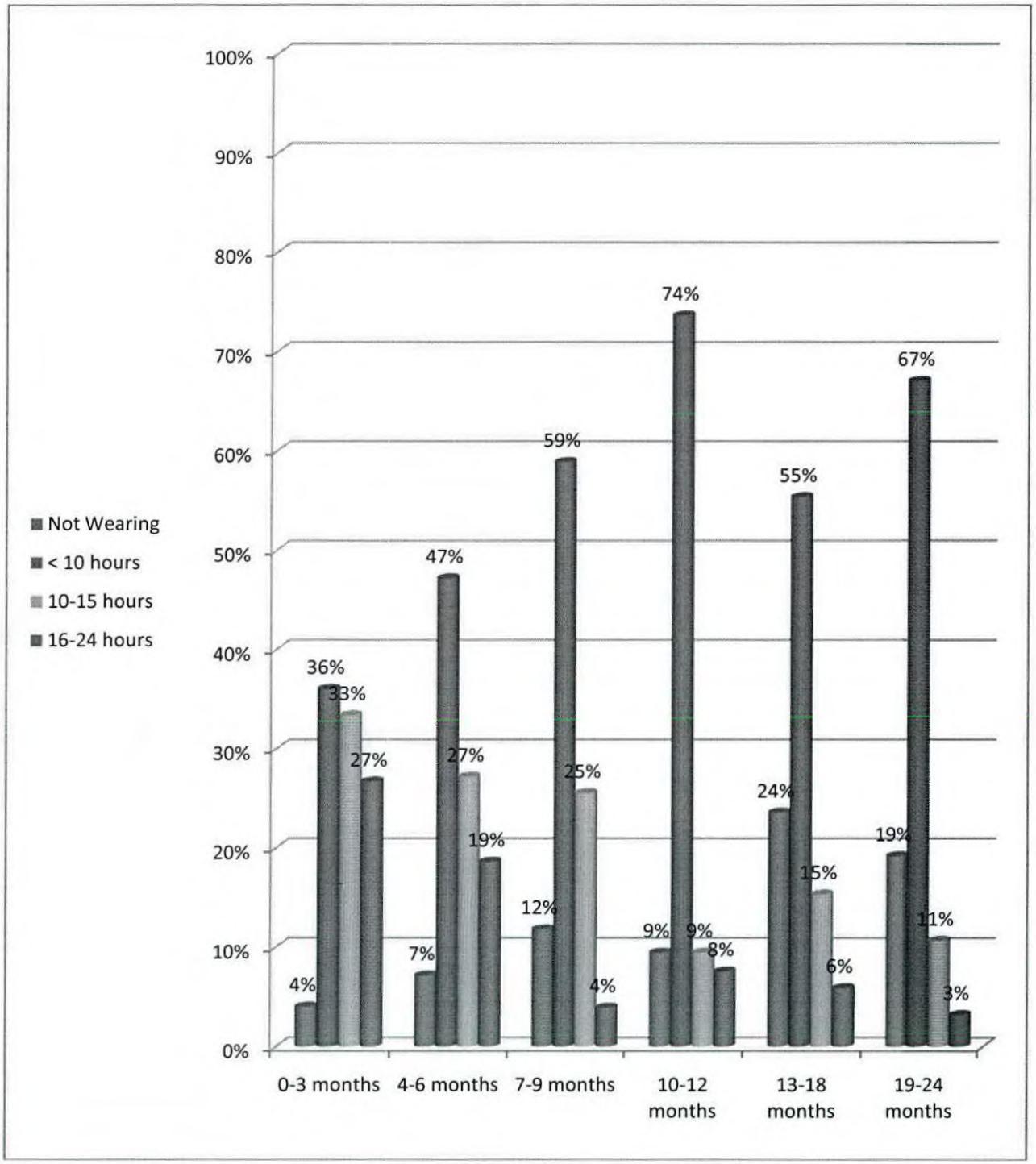


Figure 2: Nights per week patients are wearing their retainers by length of time since debond

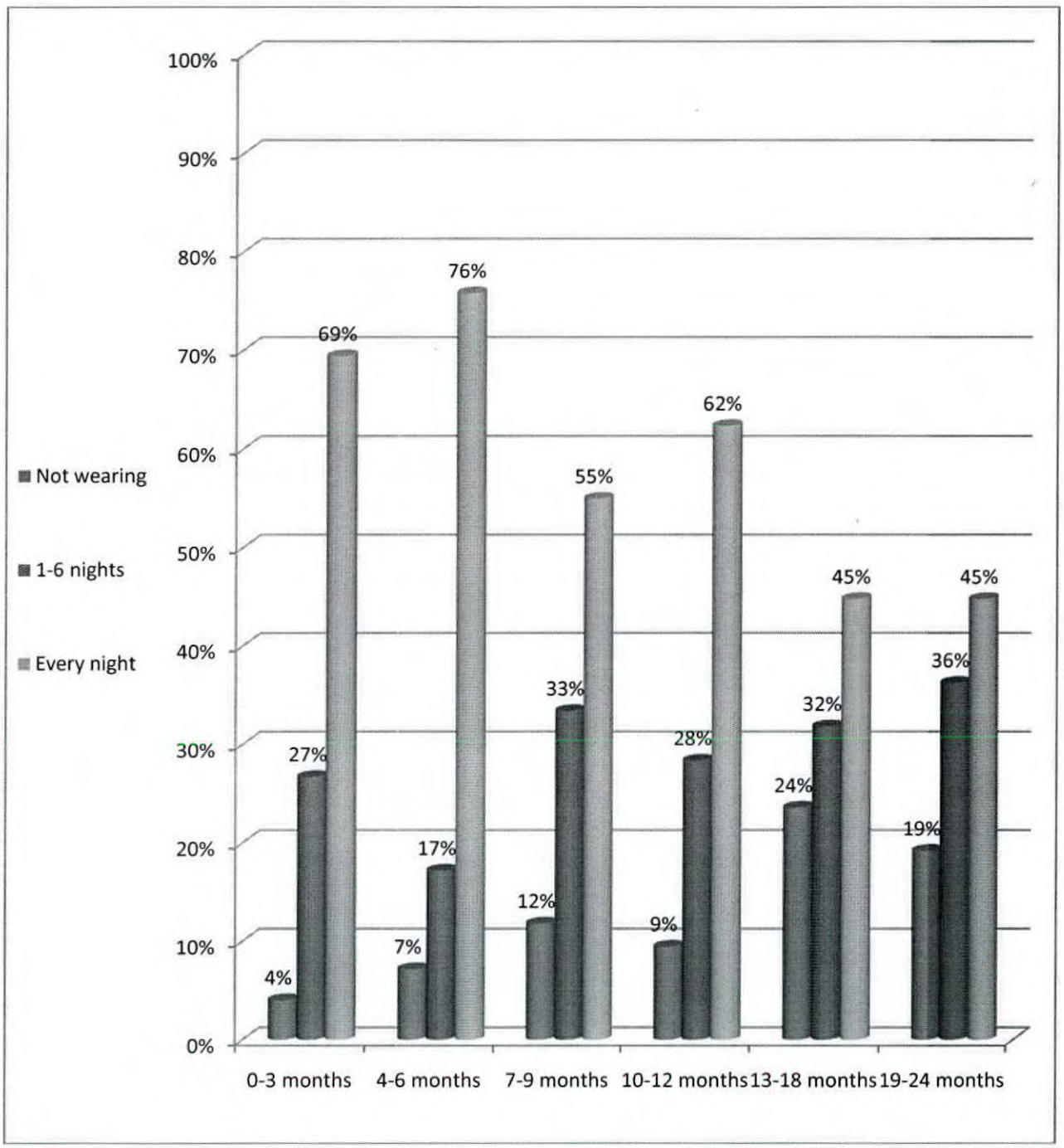
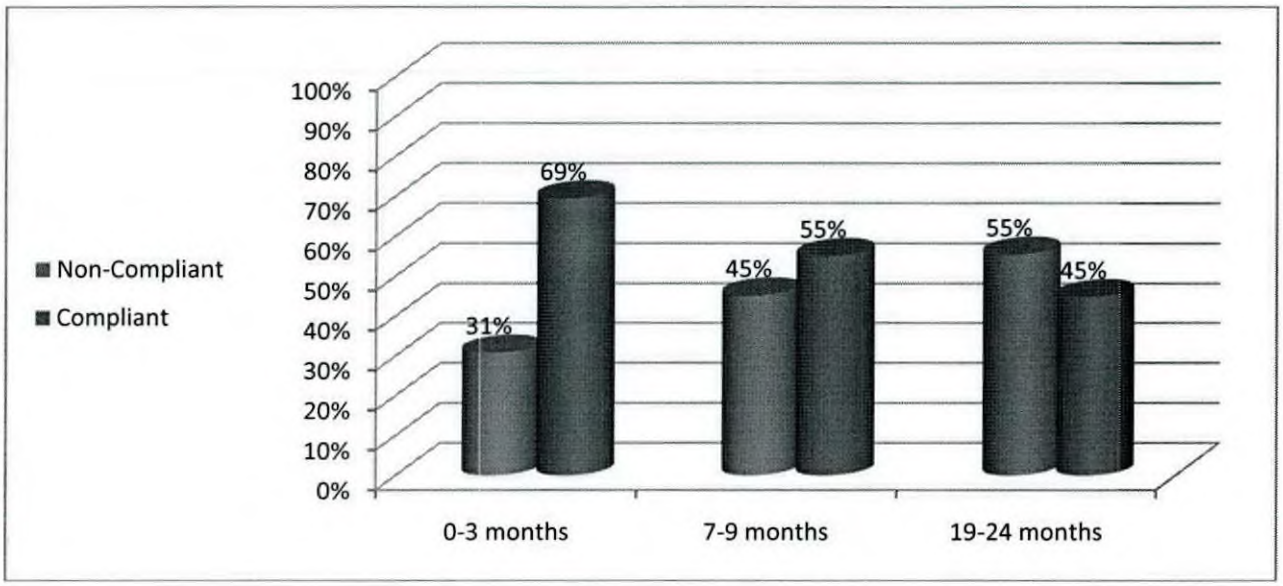


Figure 3: Overall Compliance with prescribed nightly wear by length of time since debond



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APPENDIX 1

TABLES

Table 1 – Frequency and Percent Distribution of Respondents by Individual Offices

Variables	N	%
Office 1	110	25.7%
Office 2	93	21.7%
Office 3	122	28.5%
Office 4	103	24.1%
Total Sample	**428**	**100%**

Table 2 – Frequency and Percent Distribution of Age

Variables	N	%
13 and younger	42	9.8%
14	53	12.4%
15	106	24.8%
16	75	17.5%
17	66	15.4%
18 and older	86	20.1%
Total	**428**	**100%**

Table 3 – Frequency and Percent Distribution of Length of Time since Debond

Variable	N	%
0-3 months	75	17.5%
4-6 months	70	16.4%
7-9 months	51	11.9%
10-12 months	53	12.4%
13-18 months	85	19.9%
19-24 months	94	22.0%
Total	**428**	**100%**

Table 4 – Frequency and Percent Distribution of Maxillary and Mandibular Retainers

Variables	Total Maxillary Retainer	Percentage Maxillary Retainer	Total Mandibular Retainer	Percentage Mandibular Retainer
Trutain	284	66.4%	120	28.0%
Hawley	138	32.2%	14	3.3%
Bonded	1	.2%	271	63.3%
Other	5	1.2%	23	5.4%
Total	**428**	**100%**	**428**	**100%**

Table 5 – Frequency and Percent Distribution of Hours per Day Wearing Retainers

Variables	Total N	Percentage %
Not wearing retainers anymore	57	13.3%
≤ 10 hours	239	55.8%
10-15 hours	85	19.9%
16-24 hours	47	11.0%
Total	**428**	**100%**

Table 6 – Frequency and Percent Distribution of Nights per Week Wearing Retainers

	Total	Percentage
Variables	N	%
Not wearing retainers anymore	57	13.3%
1-6 nights	125	29.2%
Every night	246	57.5%
Total	428	100%

Table 7 – Type of Maxillary Retainer worn – Office 1

	Total	Percentage
Variables	N	%
Trutain	43	45.7%
Hawley	49	52.1%
Other	1	1.1%
Total	93	100%

APPENDIX II

FIGURES

Figure 1: Hours per day patients are wearing their retainers by Length of Time since Debond

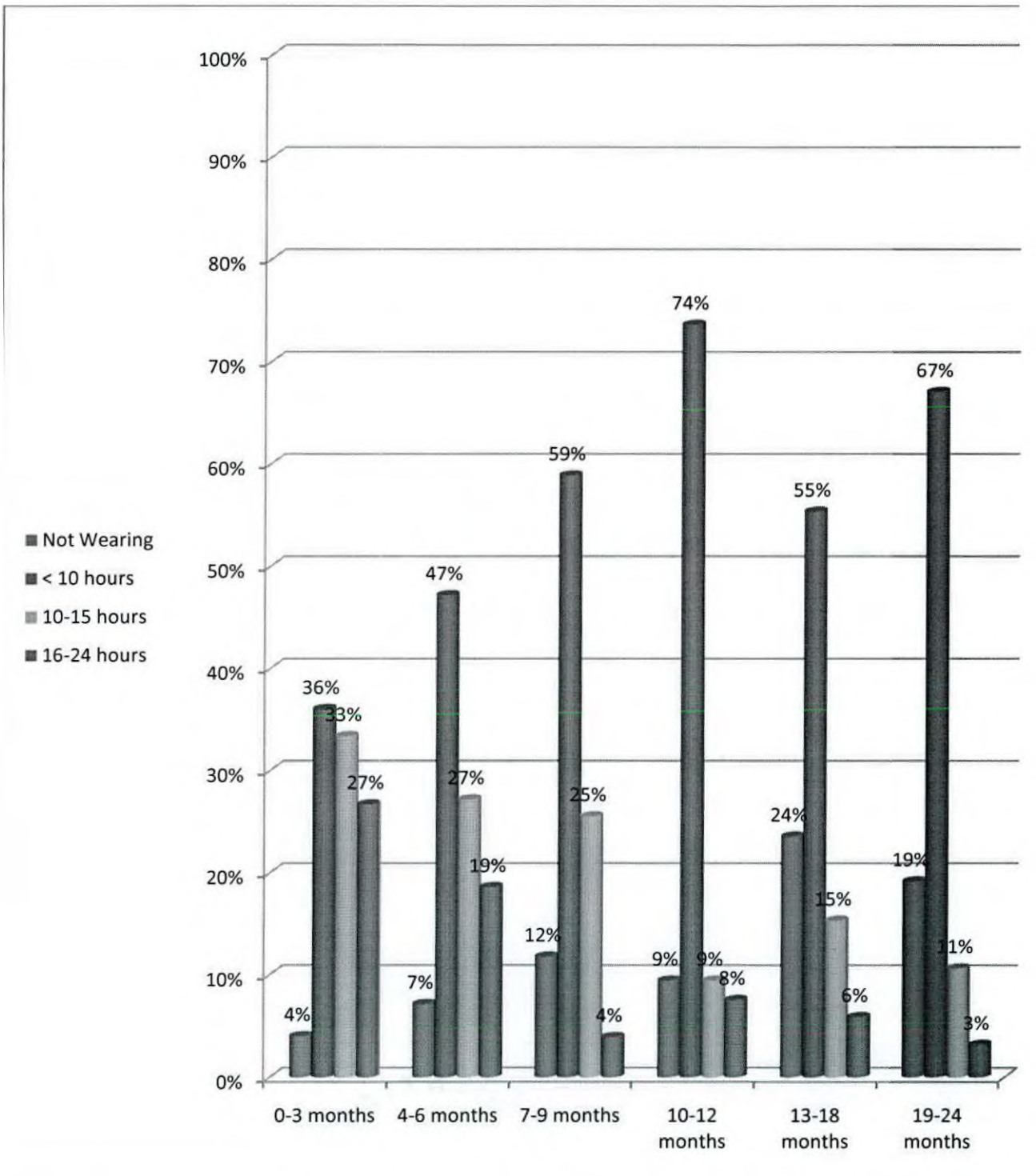


Figure 2: Nights per week patients are wearing their retainers by length of time since debond

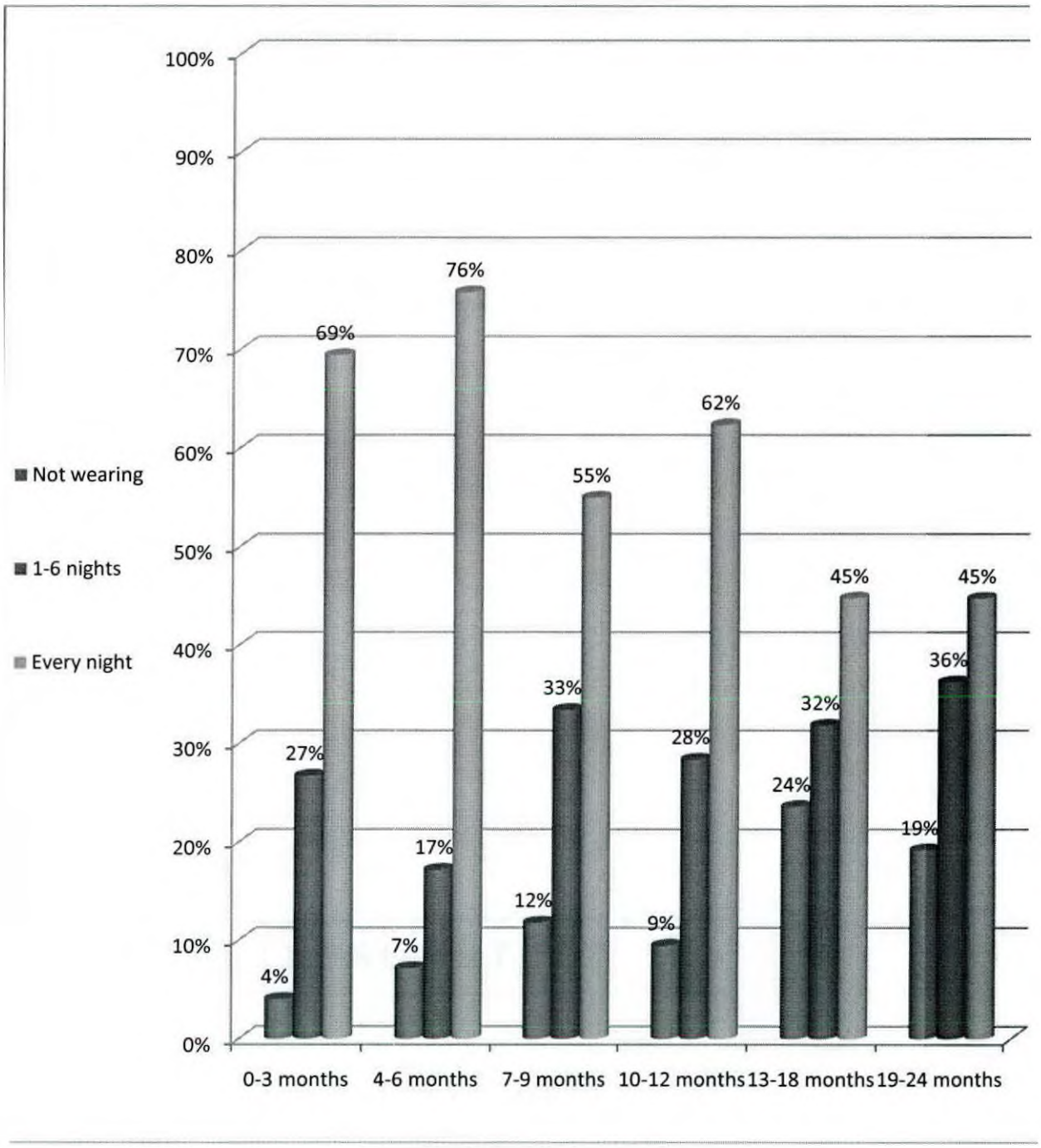


Figure 3: Hours per day patients are wearing their retainers by age

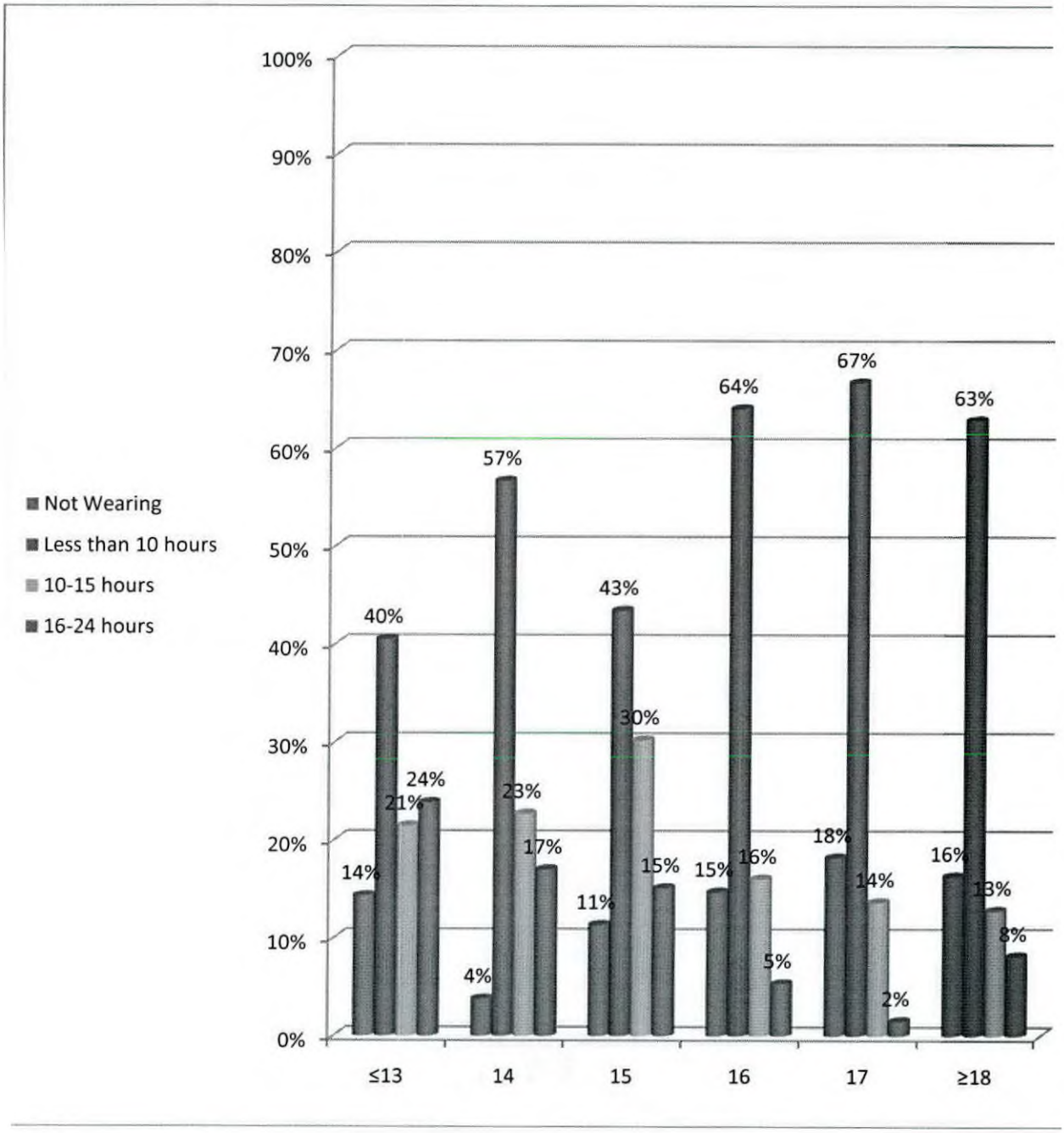


Figure 4: Nights per week patients are wearing their retainers by age

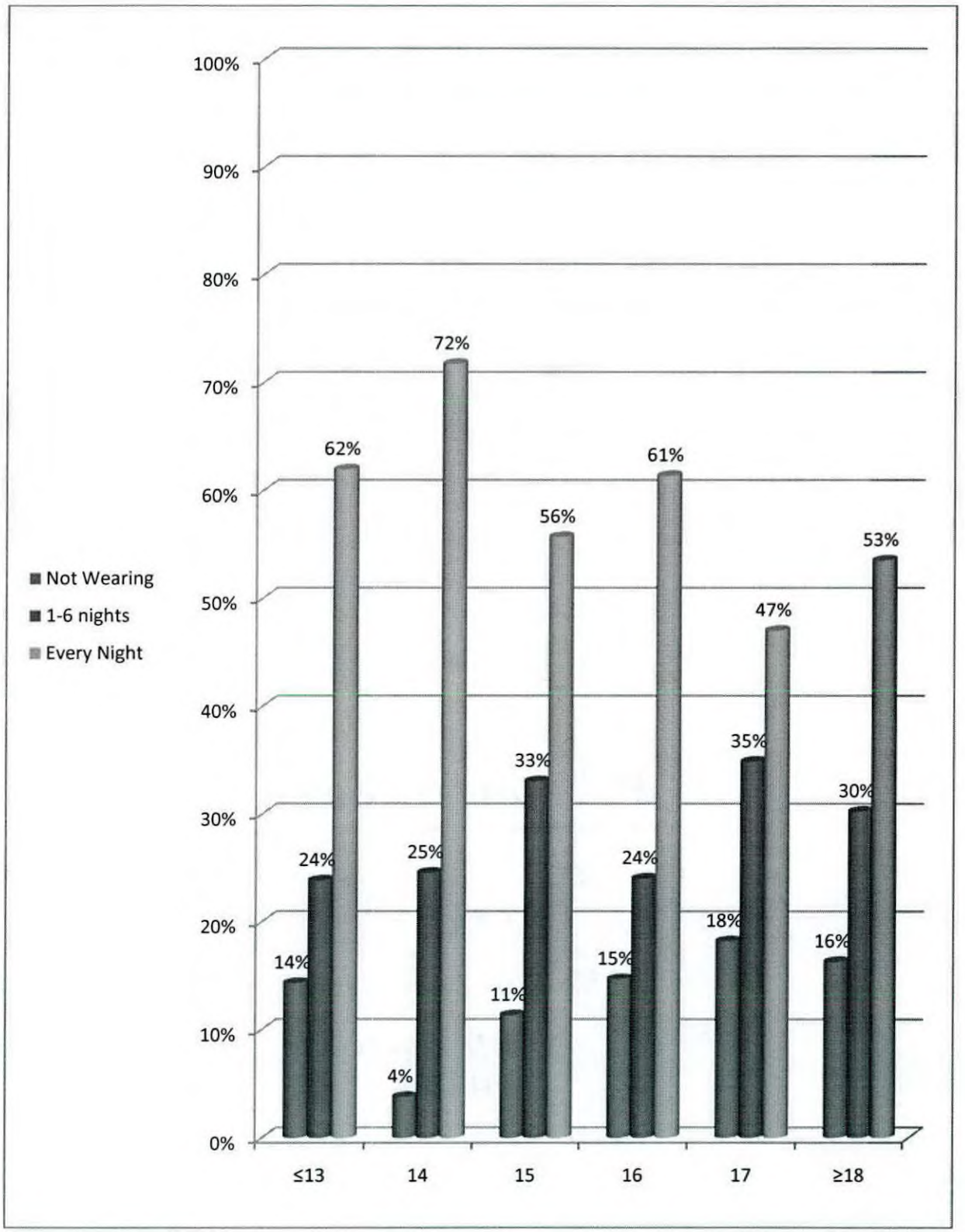


Figure 5: Hours per day patients are wearing their retainers by gender

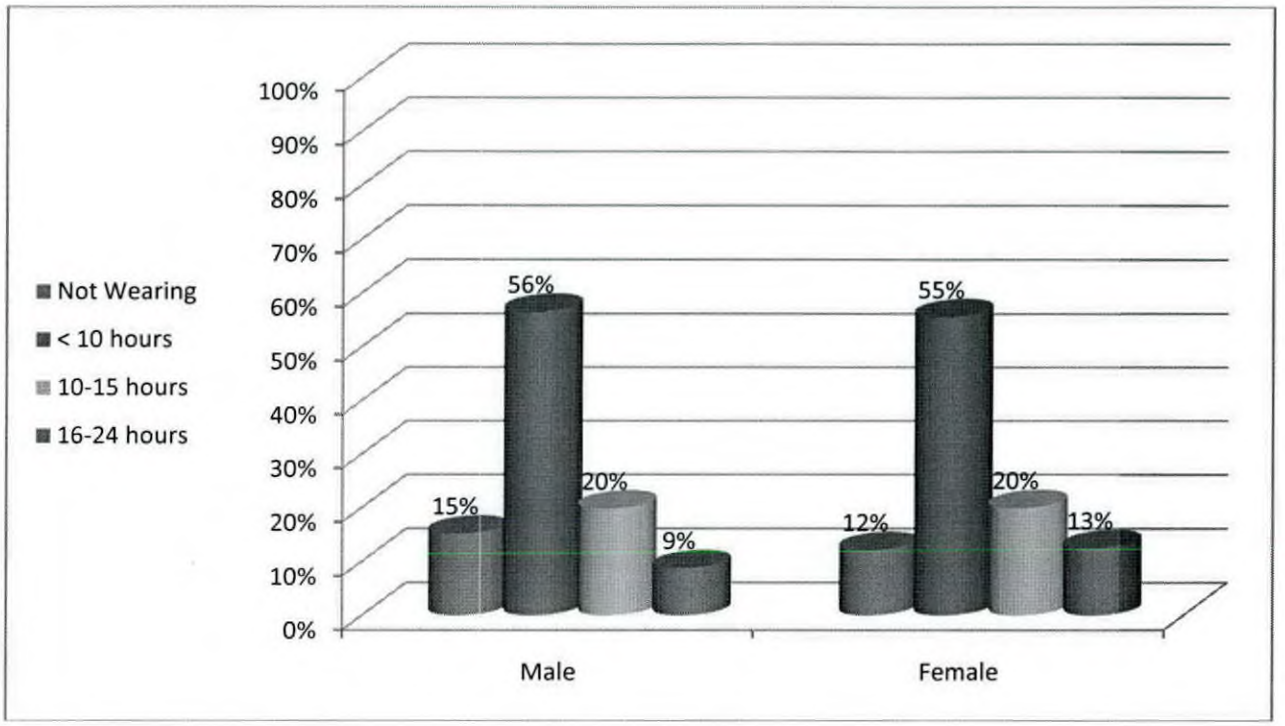


Figure 6: Nights per week patients are wearing their retainers by gender

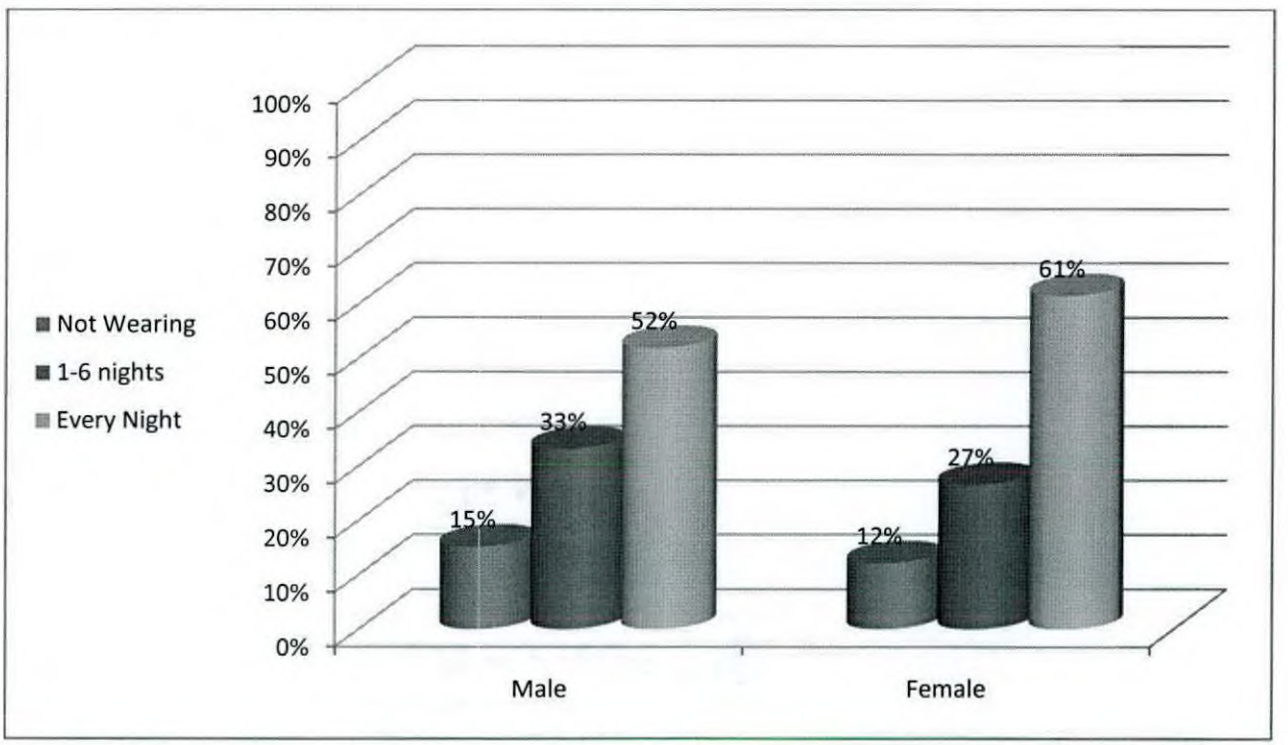


Figure 7: Hours per day patients are wearing their retainers by type of maxillary retainer

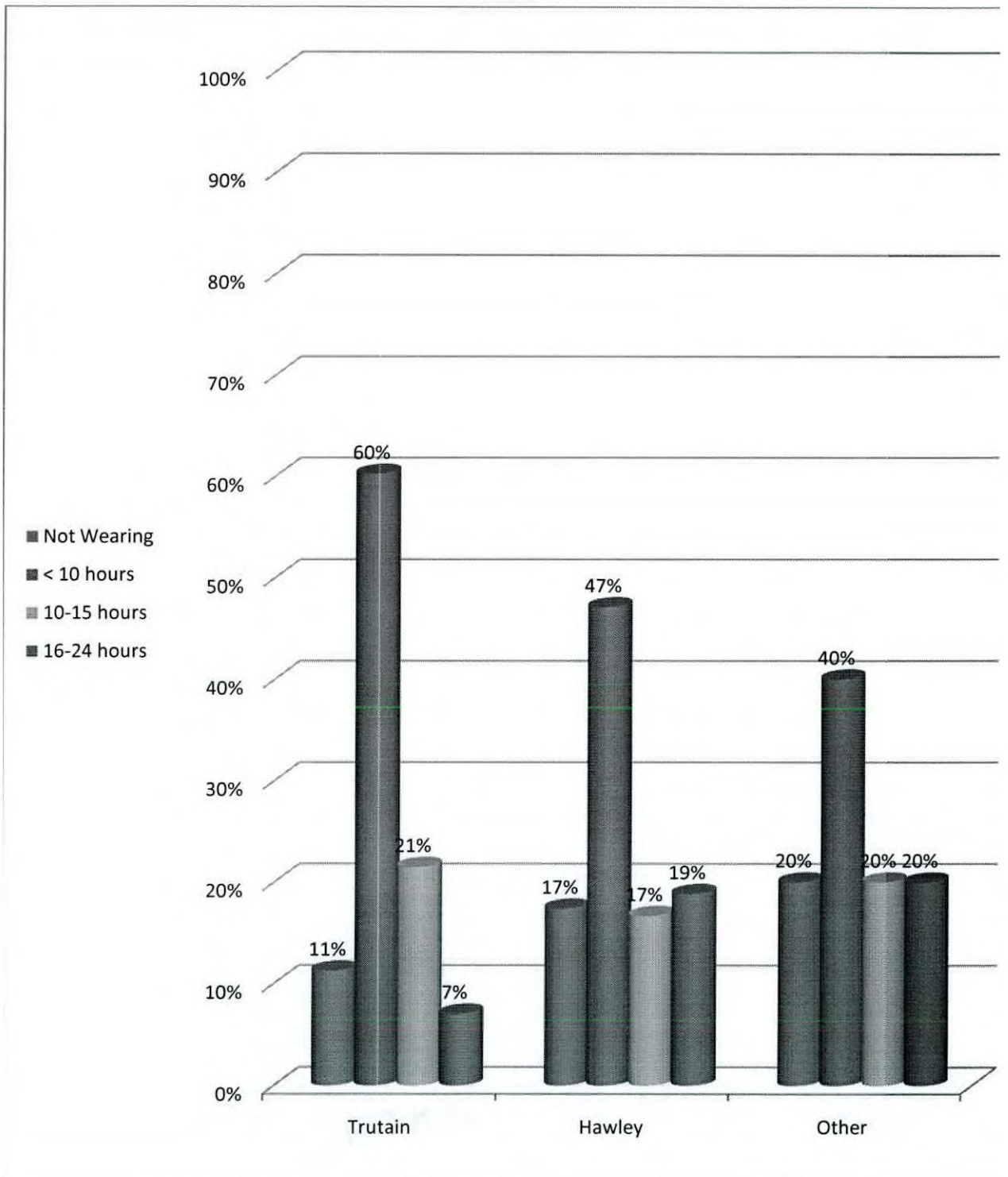


Figure 8: Nights per week patients are wearing their retainers by type of maxillary retainer

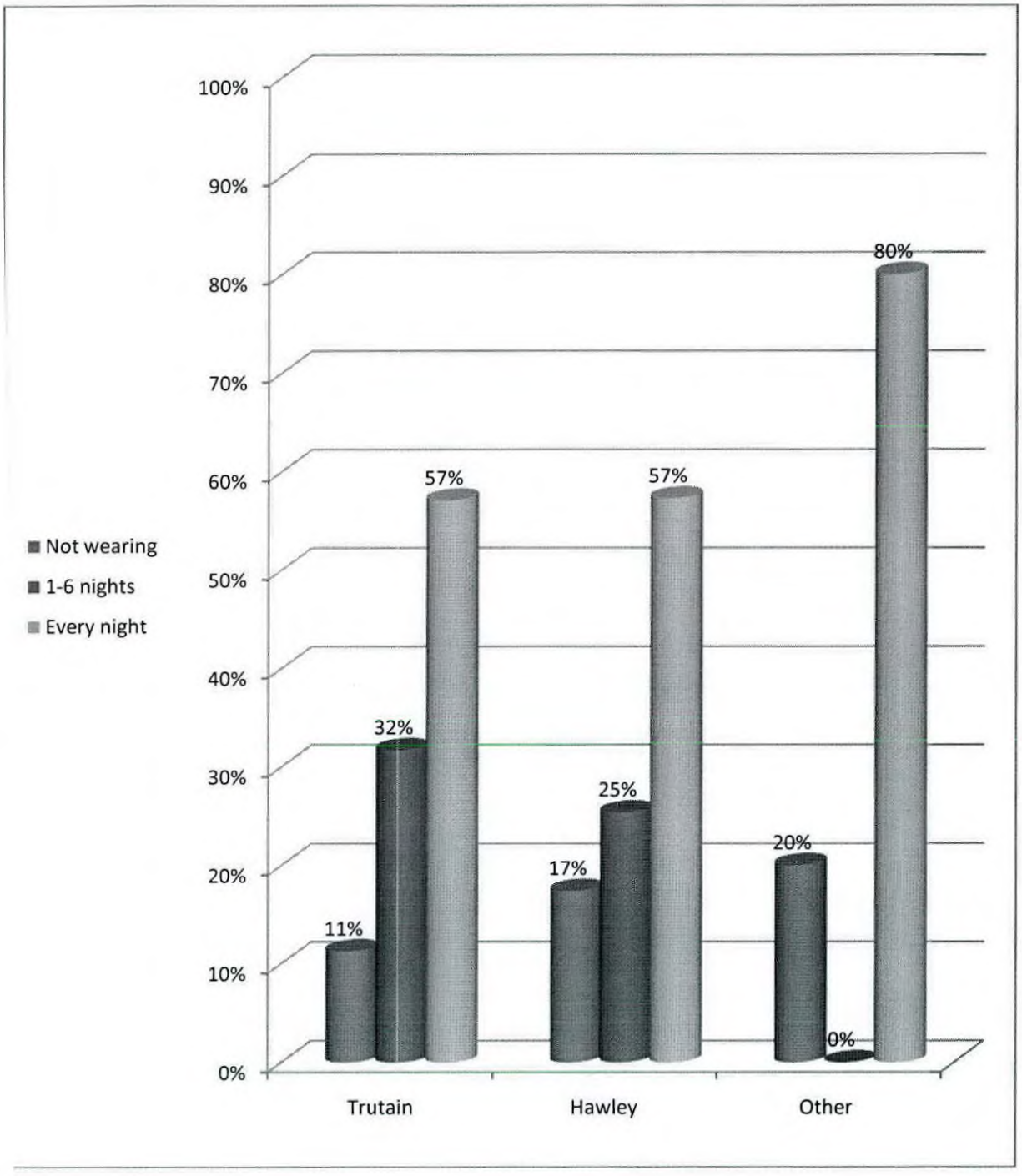


Figure 9: Hours per day patients are wearing their retainers by type of mandibular retainer

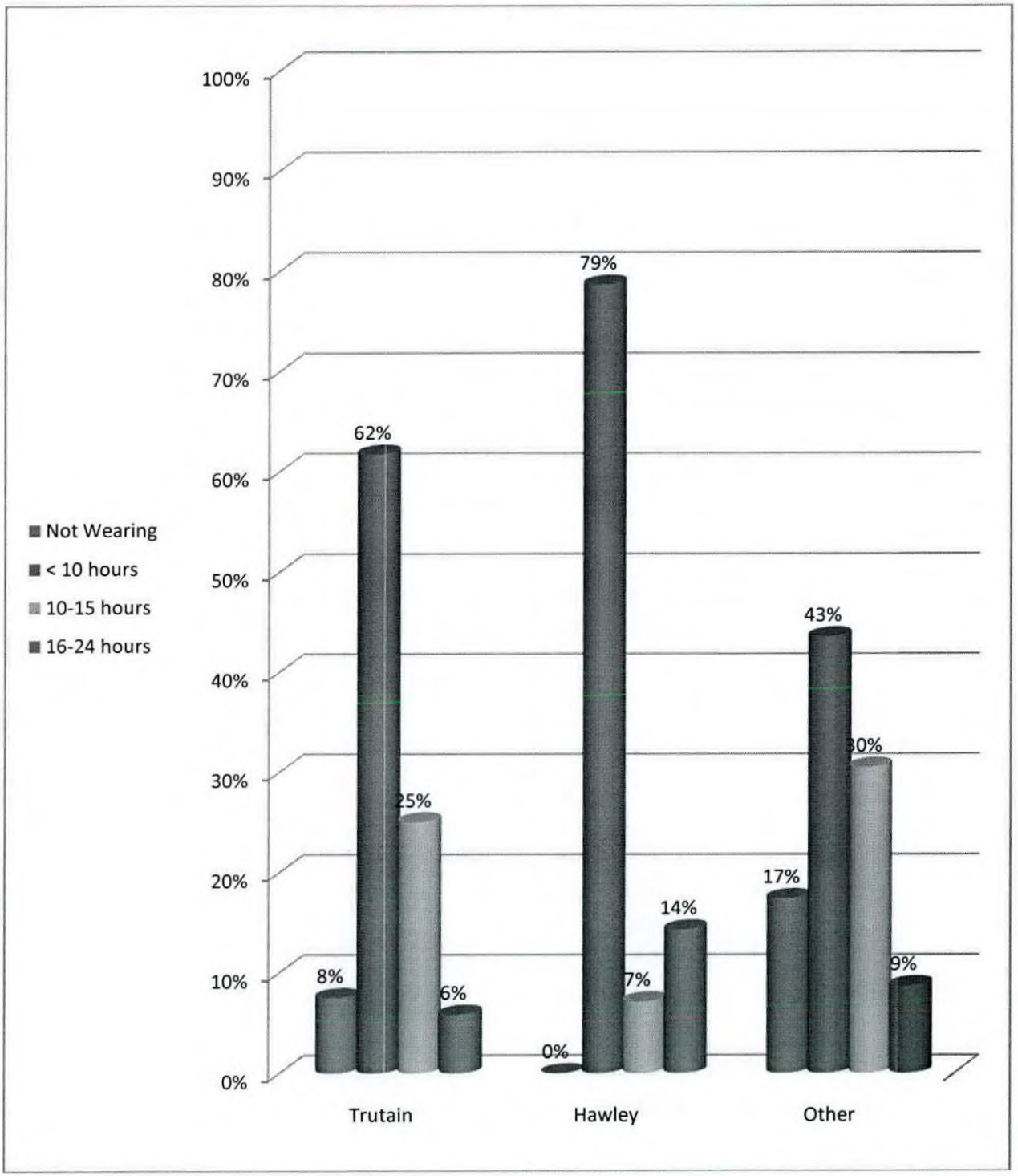


Figure 10: Nights per week patients are wearing their retainers by type of mandibular retainer

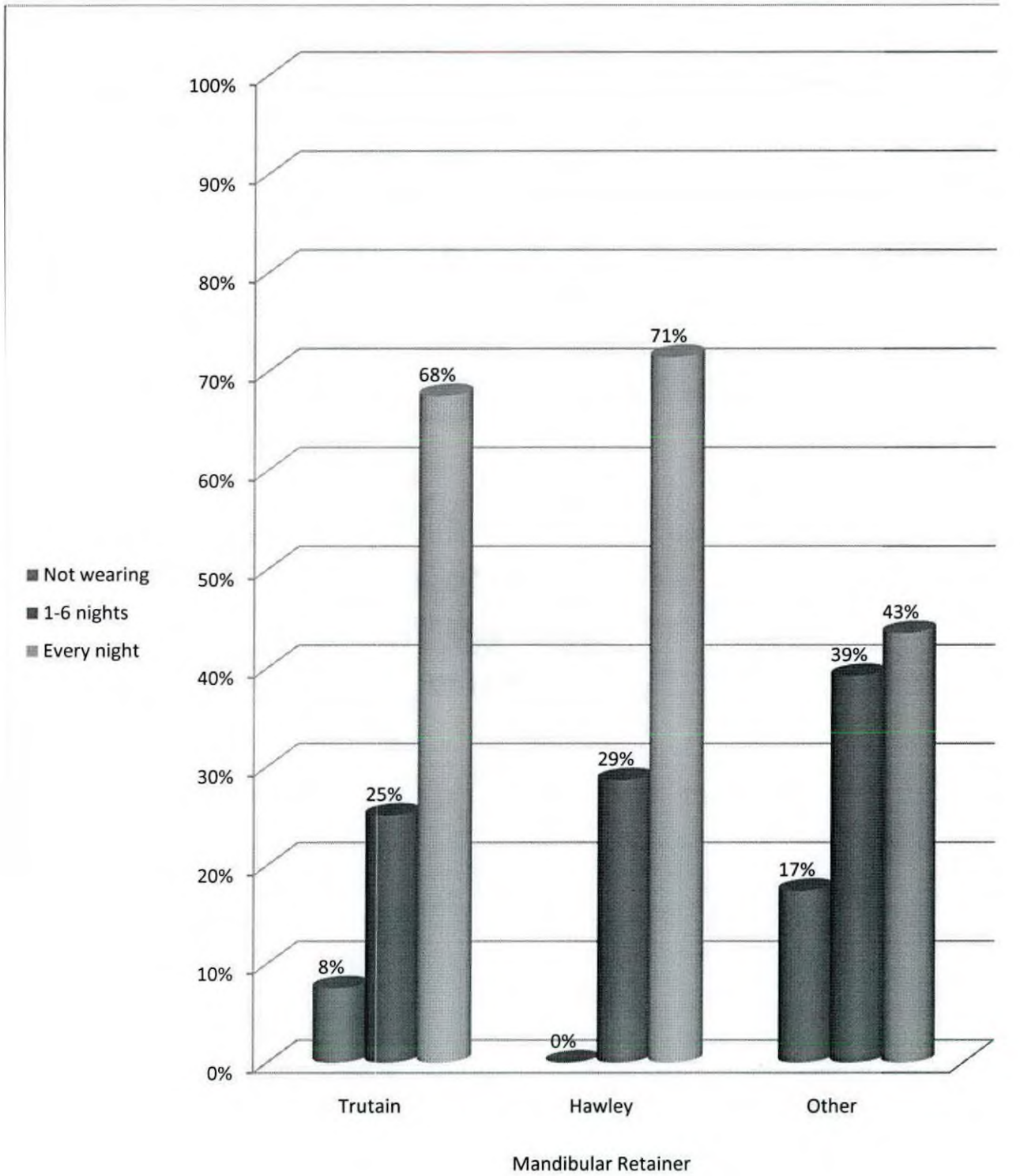
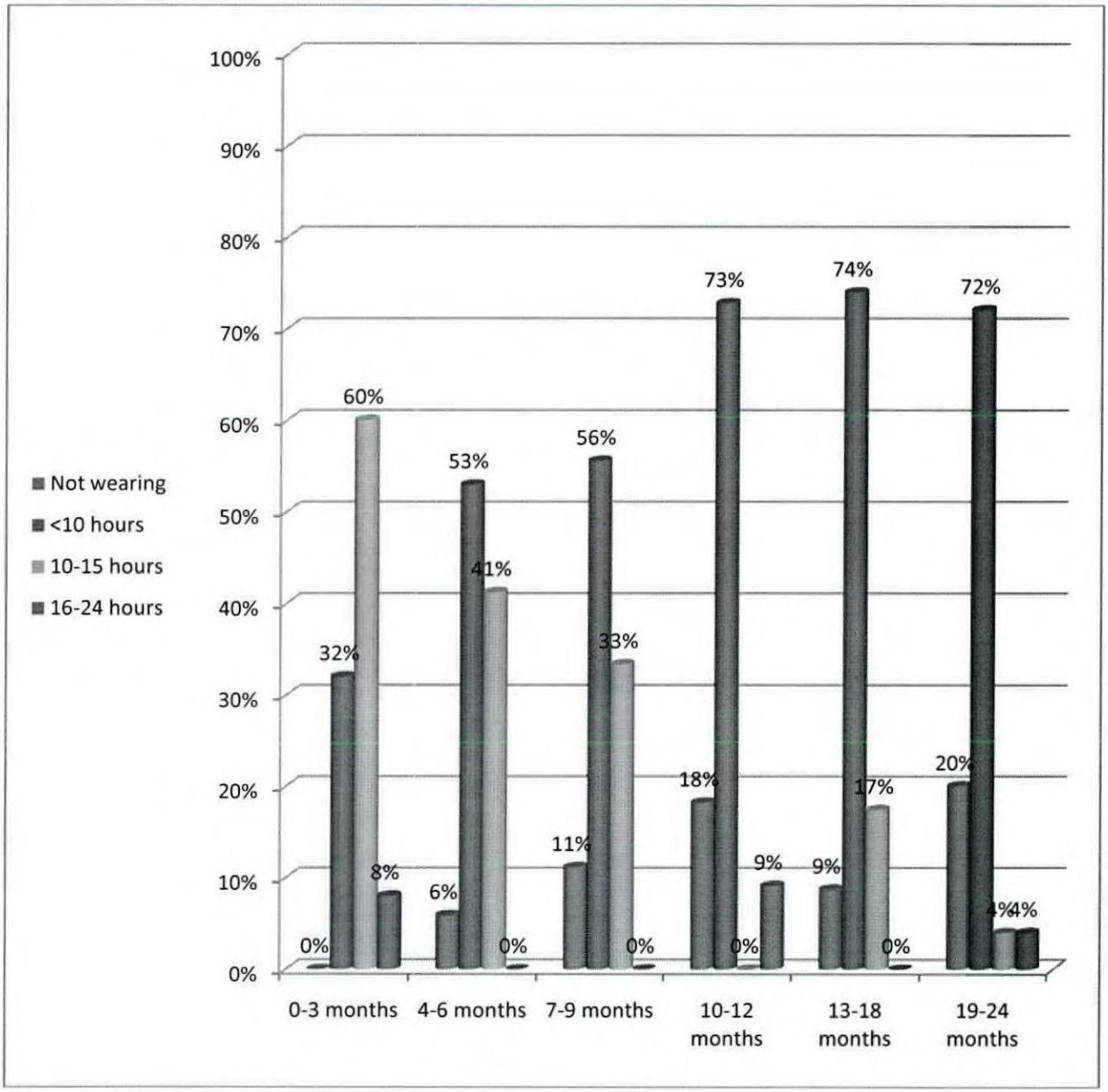


Figure 11: Hours per day patients are wearing their retainers by length of time since debond – Office 1



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Figure 12: Nights per week patients are wearing their retainers by length of time since debond – Office 1

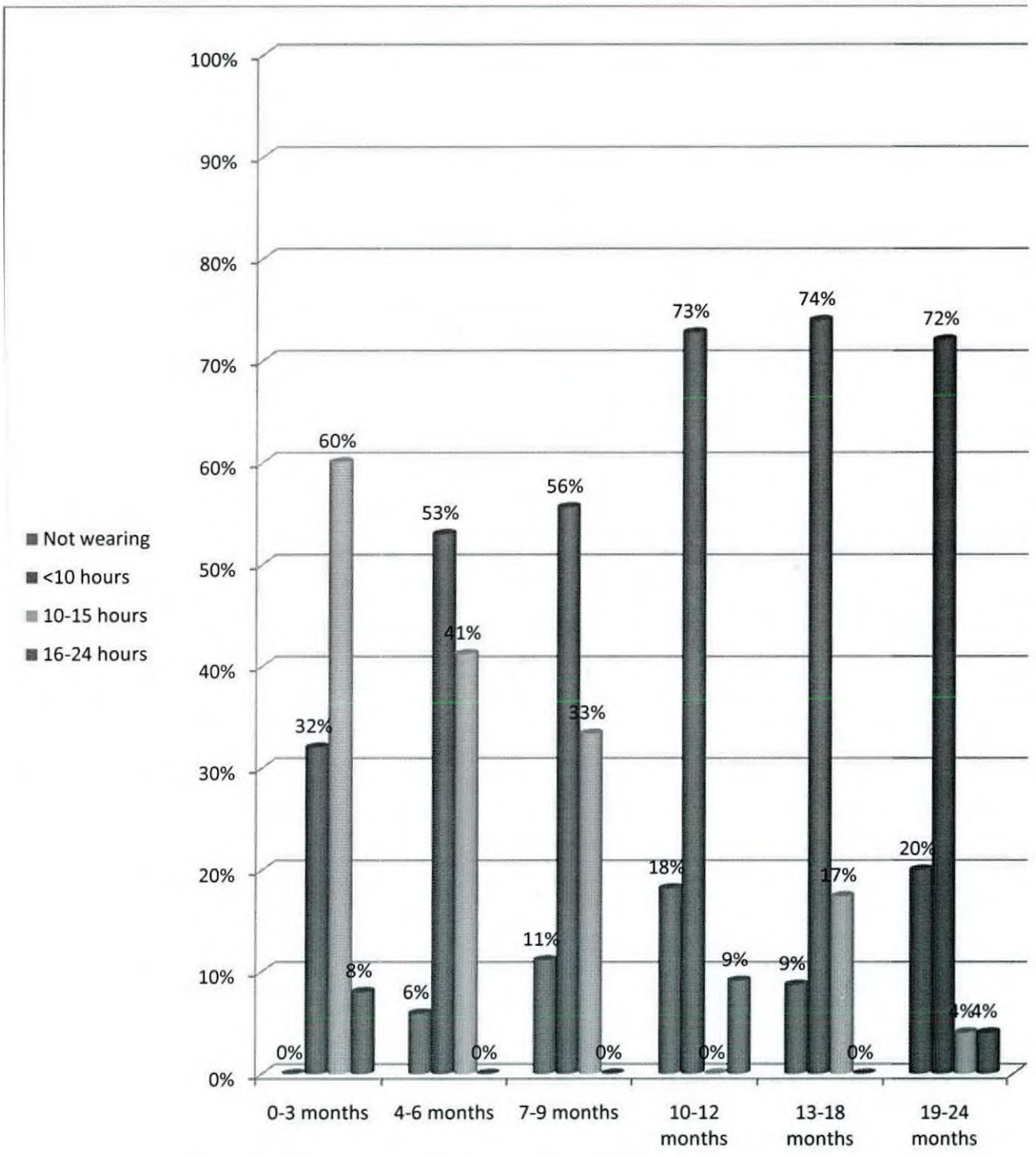


Figure 13: Hours per day patients are wearing their retainers by length of time since debond – Office 2

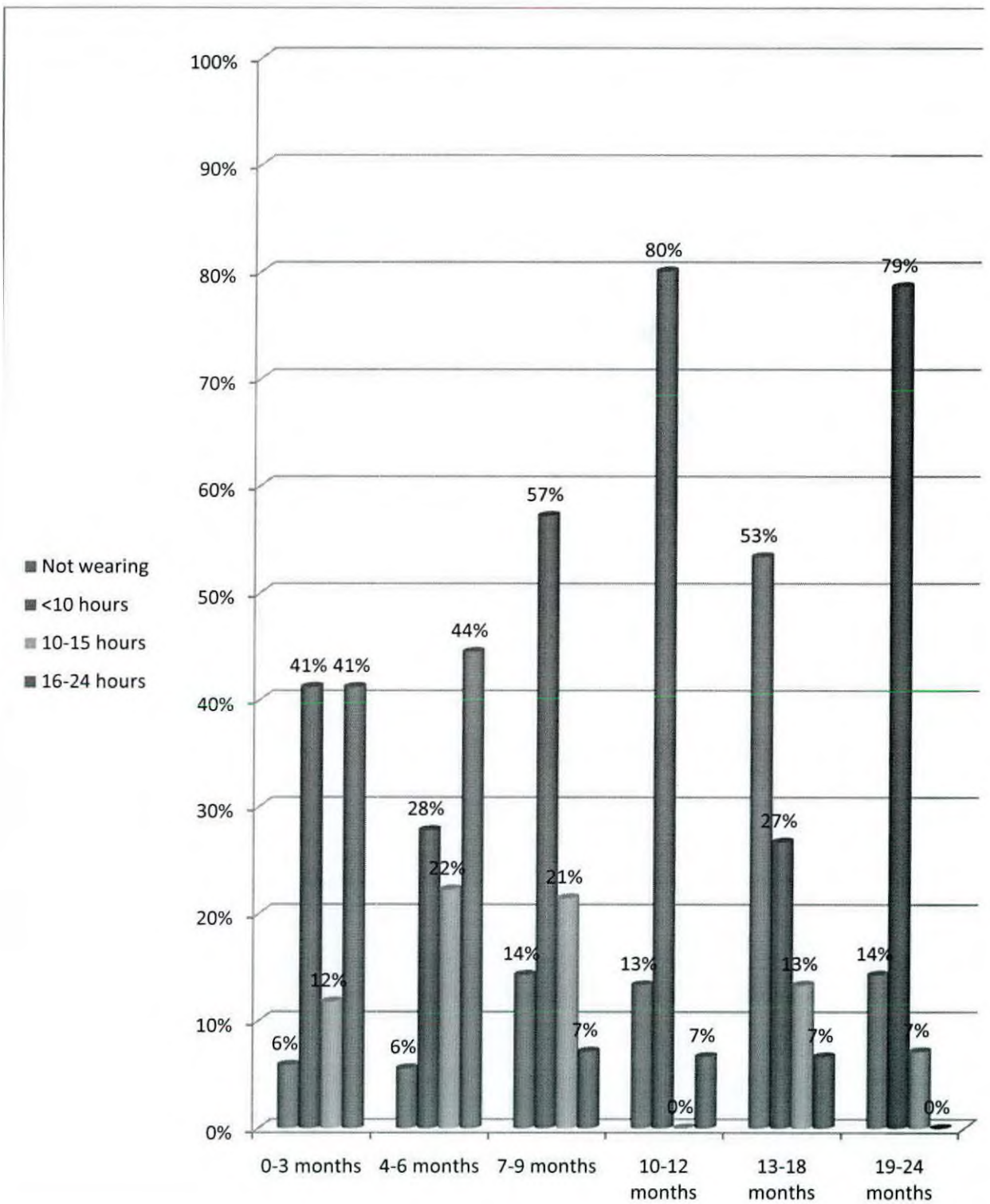


Figure 14: Nights per week patients are wearing their retainers by length of time since debond – Office 2

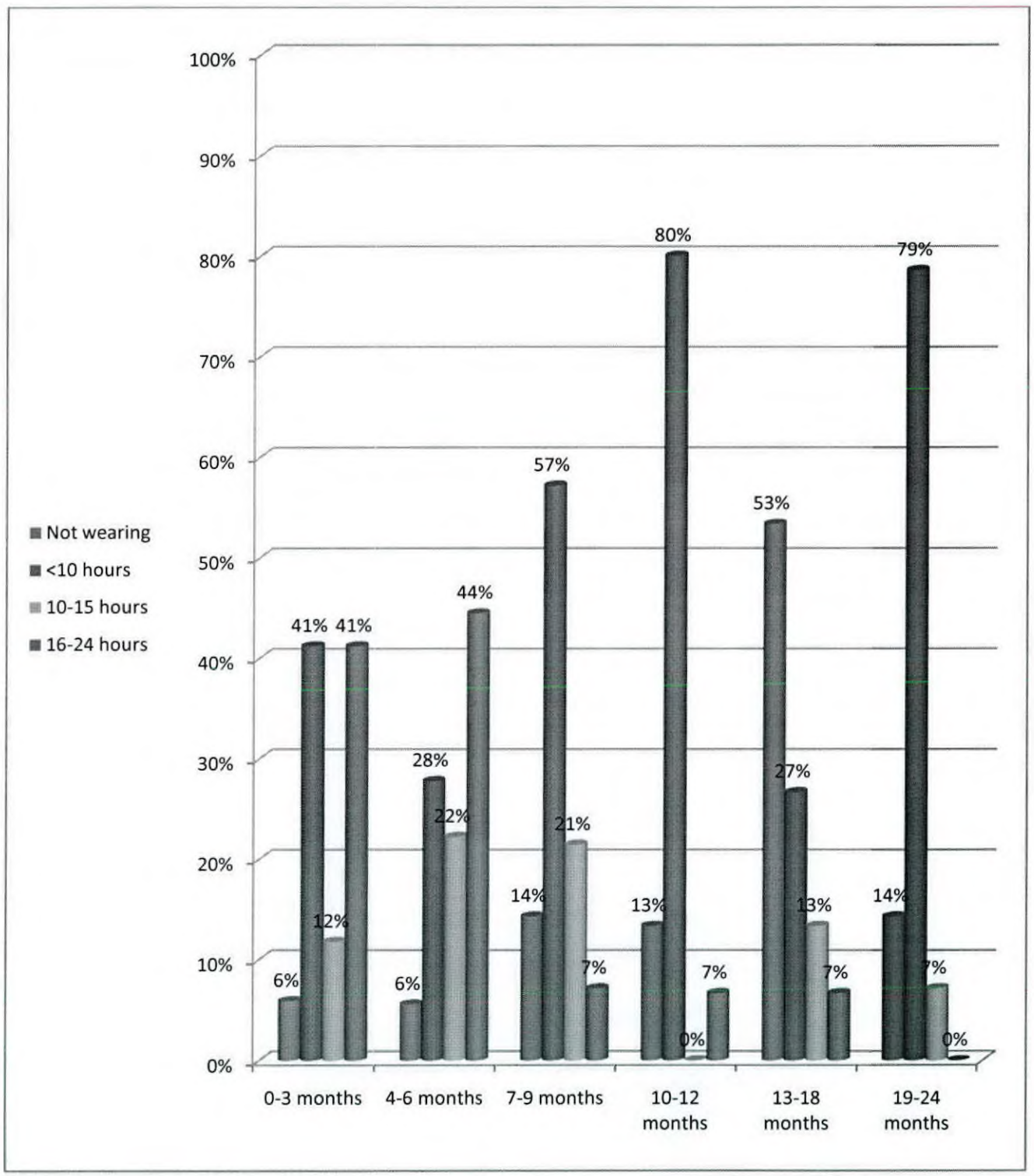


Figure 15: Hours per day patients are wearing their retainers by length of time since debond – Office 3

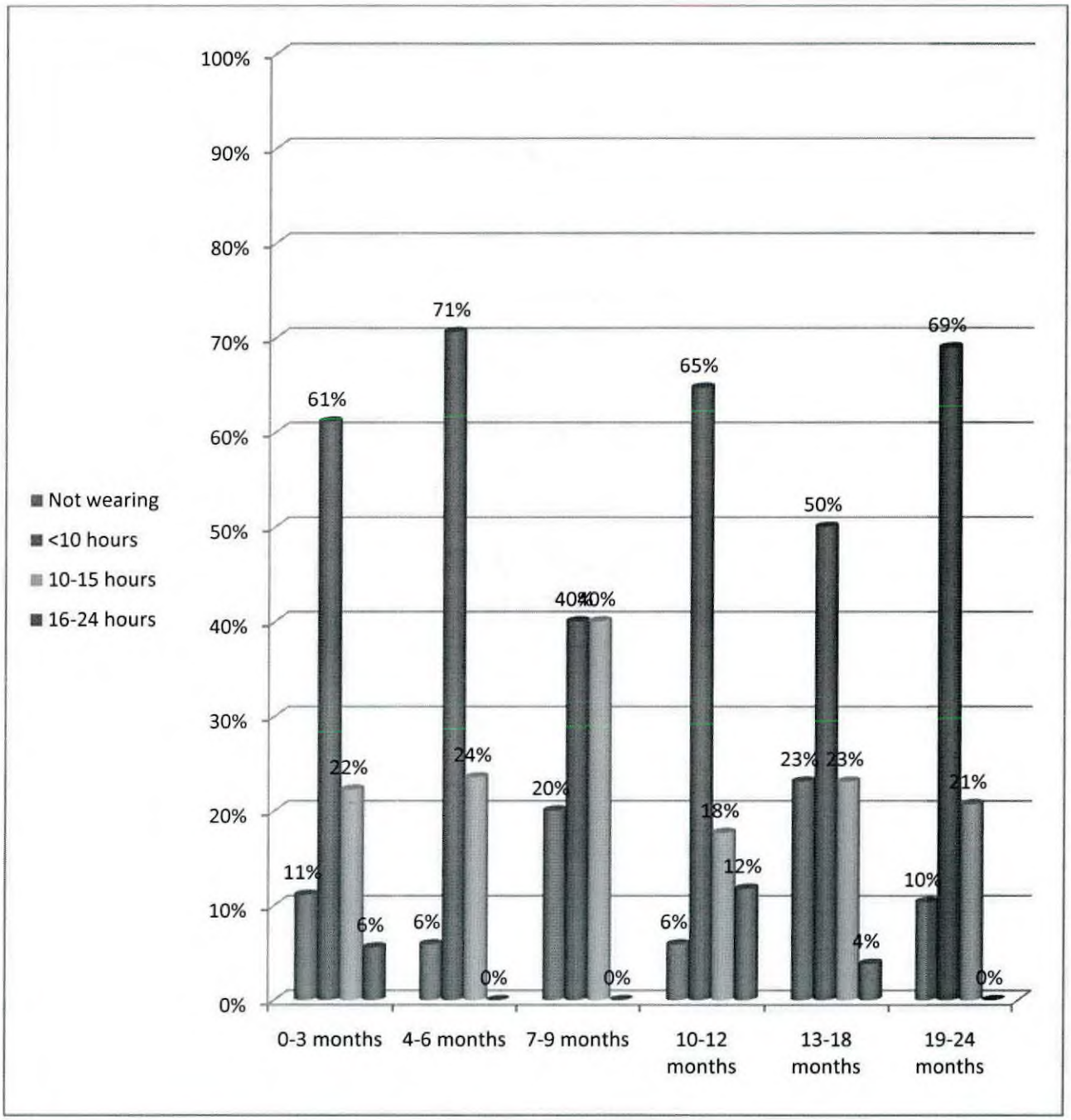


Figure 16: Nights per week patients are wearing their retainers by length of time since debond – Office 3

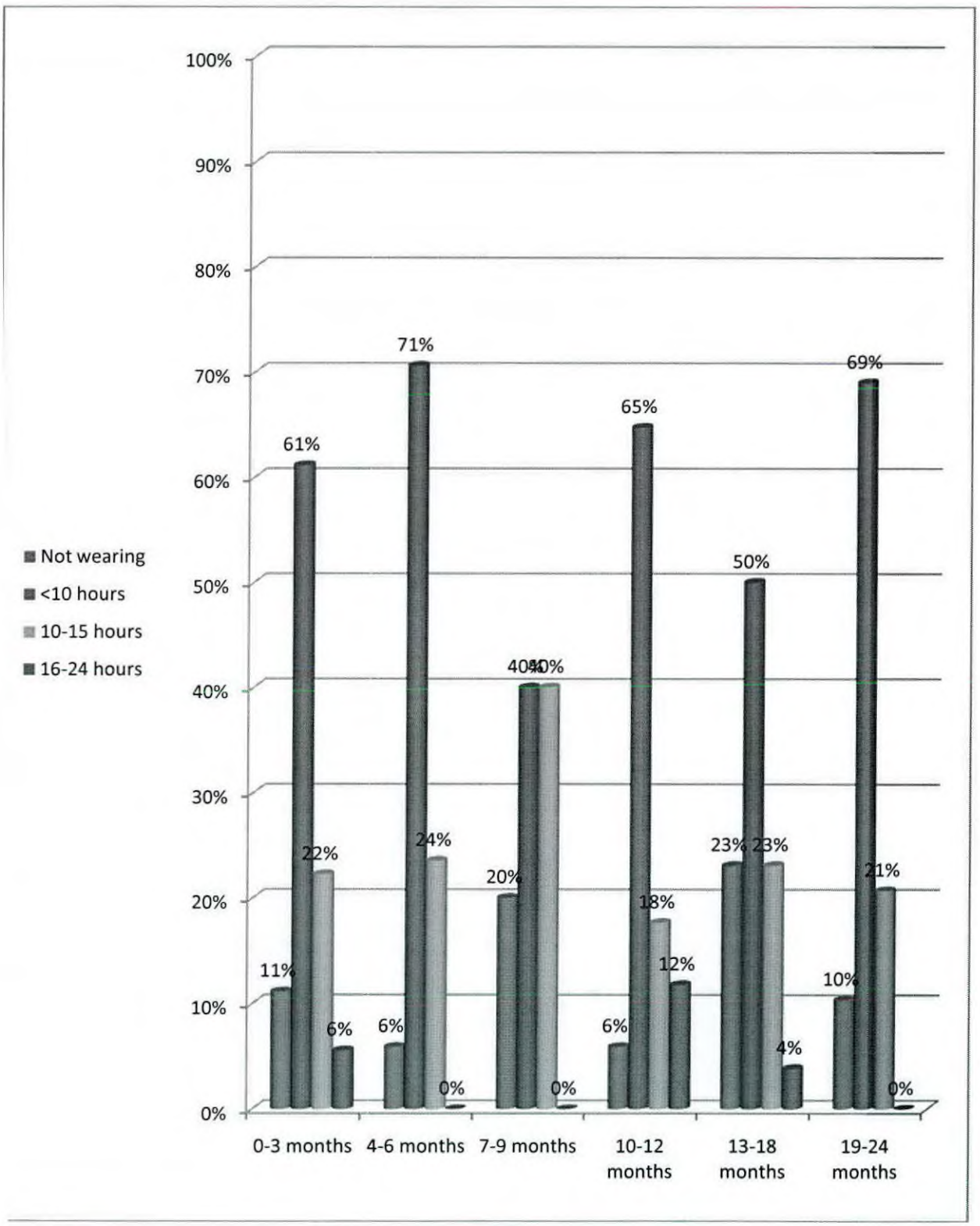


Figure 17: Hours per day patients are wearing their retainers by length of time since debond – Office 4

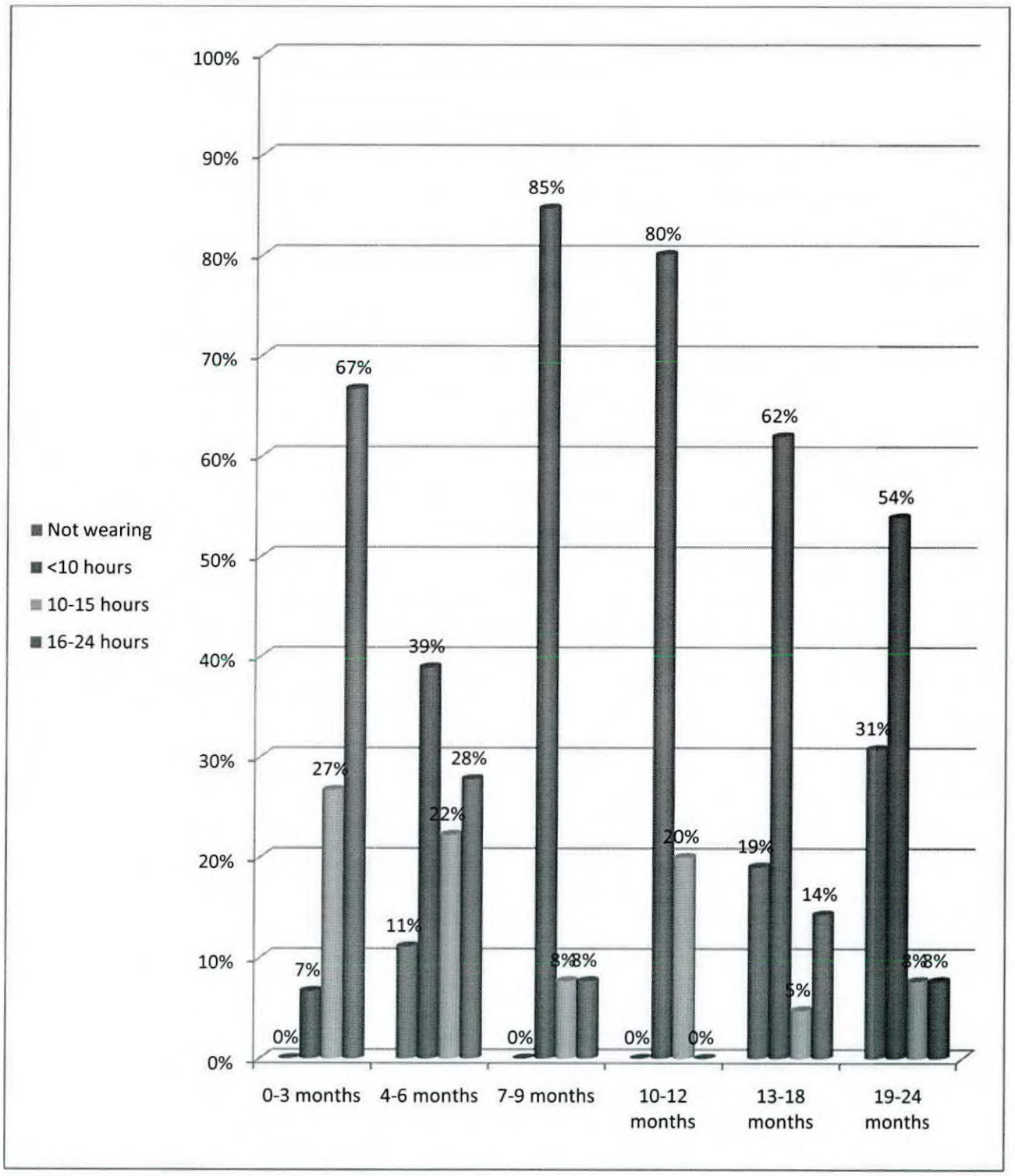


Figure 18: Nights per week patients are wearing their retainers by length of time since debond – Office 4

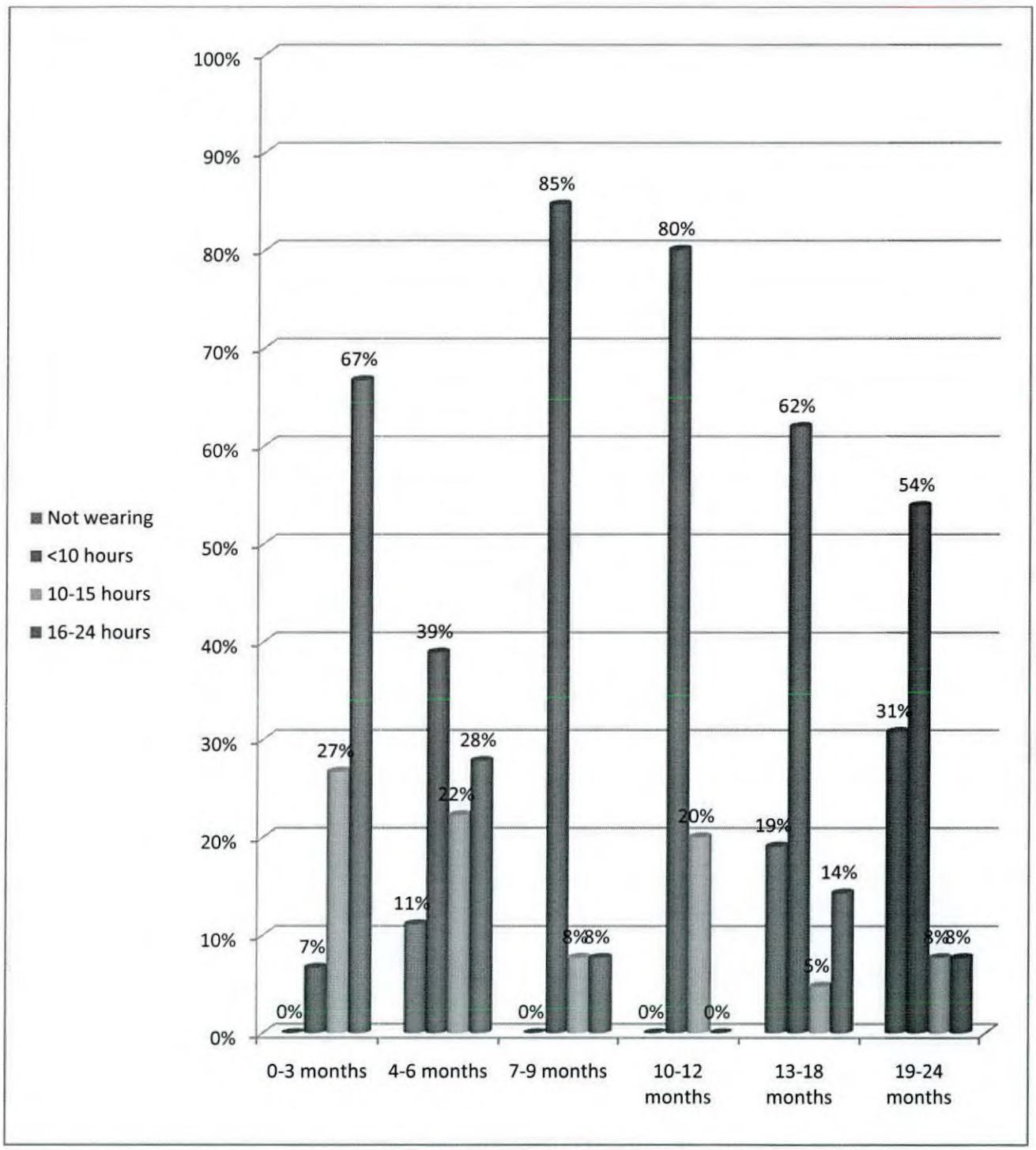


Figure 19: Overall Compliance with prescribed hourly wear

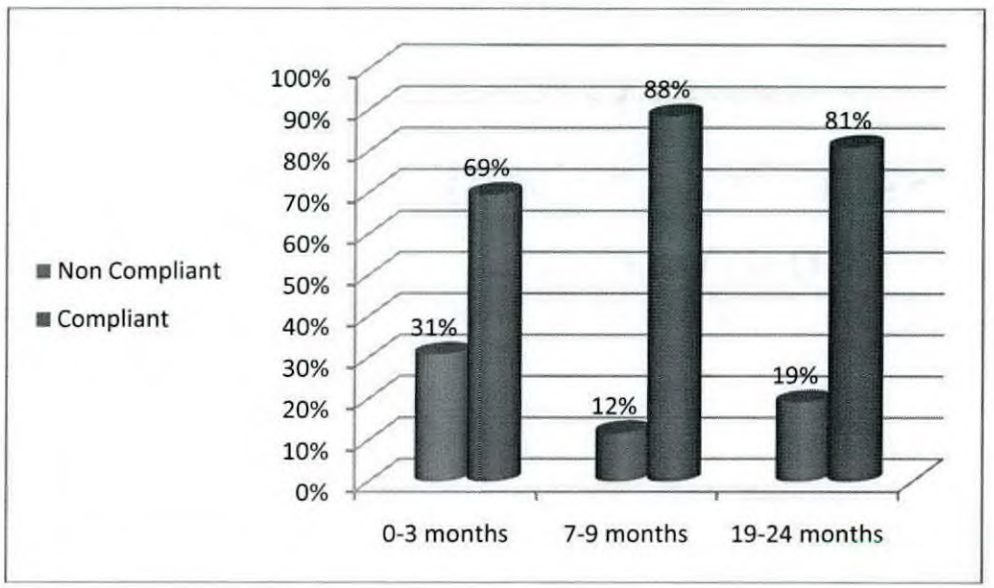


Figure 20: Overall Compliance with prescribed nightly wear

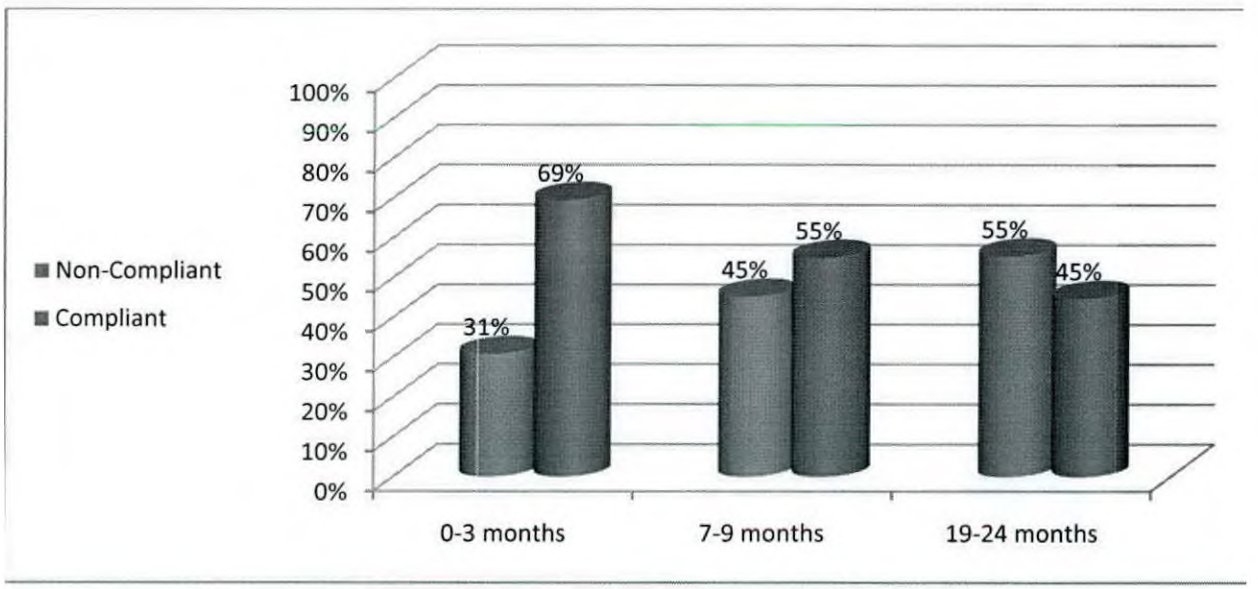


Figure 21: Compliance with prescribed hourly wear – Office 1

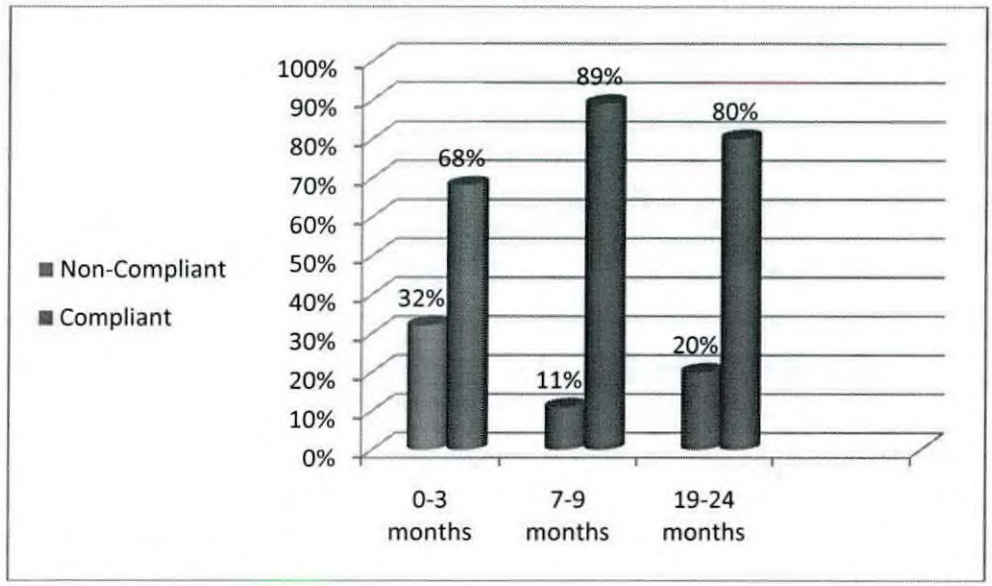


Figure 22: Compliance with prescribed hourly wear – Office 2

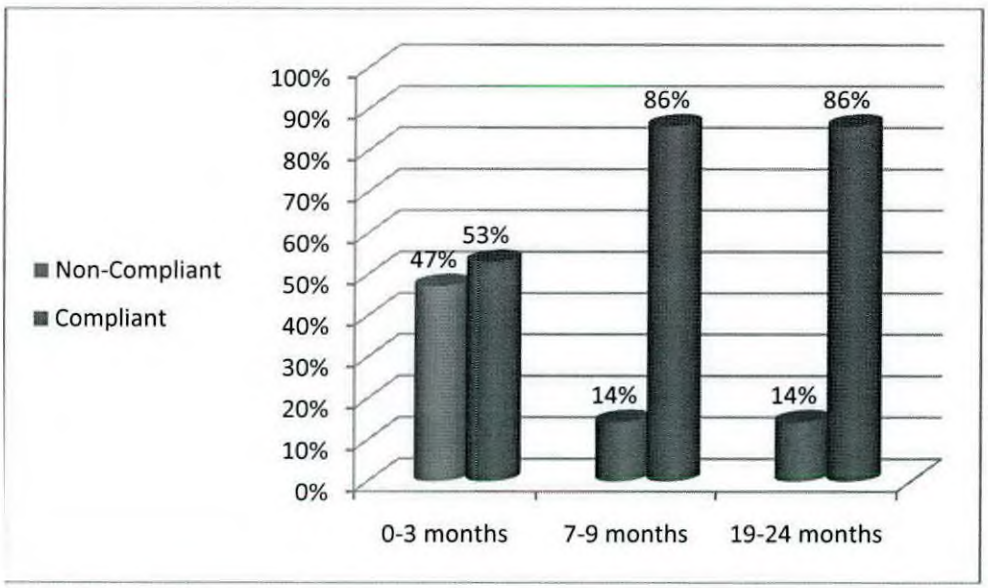


Figure 23: Compliance with prescribed hourly wear – Office 3

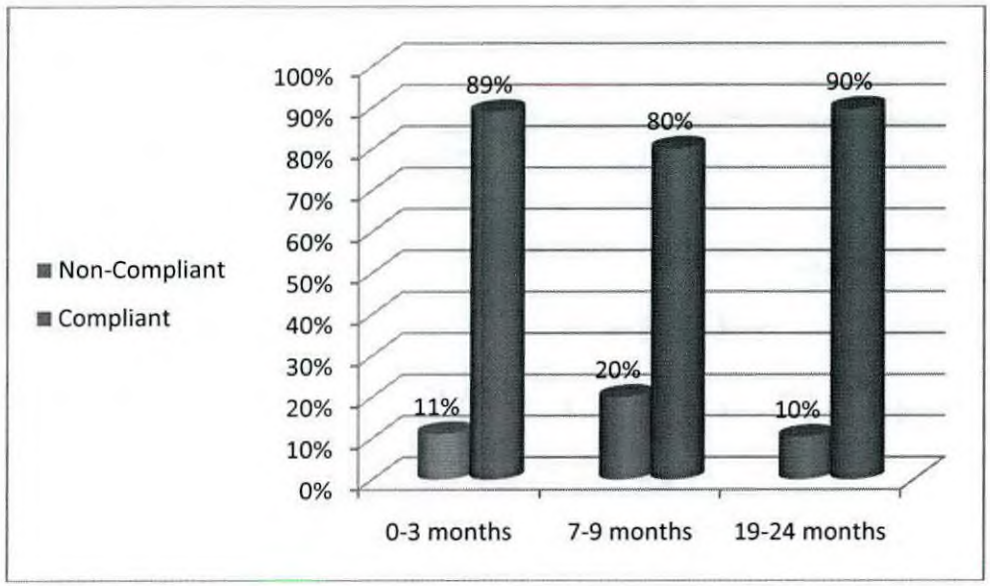


Figure 24: Compliance with prescribed hourly wear – Office 4

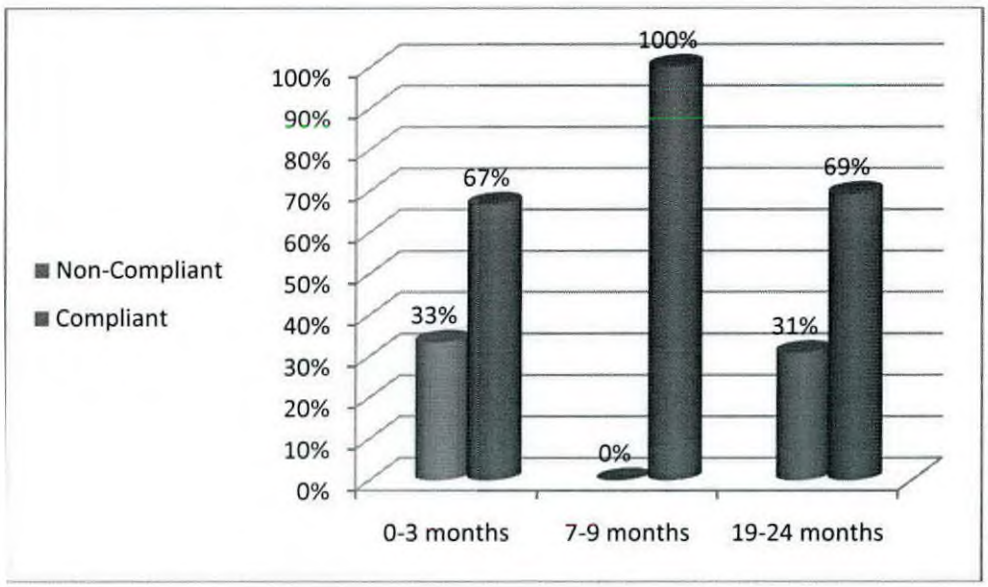


Figure 25: Nights per week patients are wearing their retainers by length of time since debond

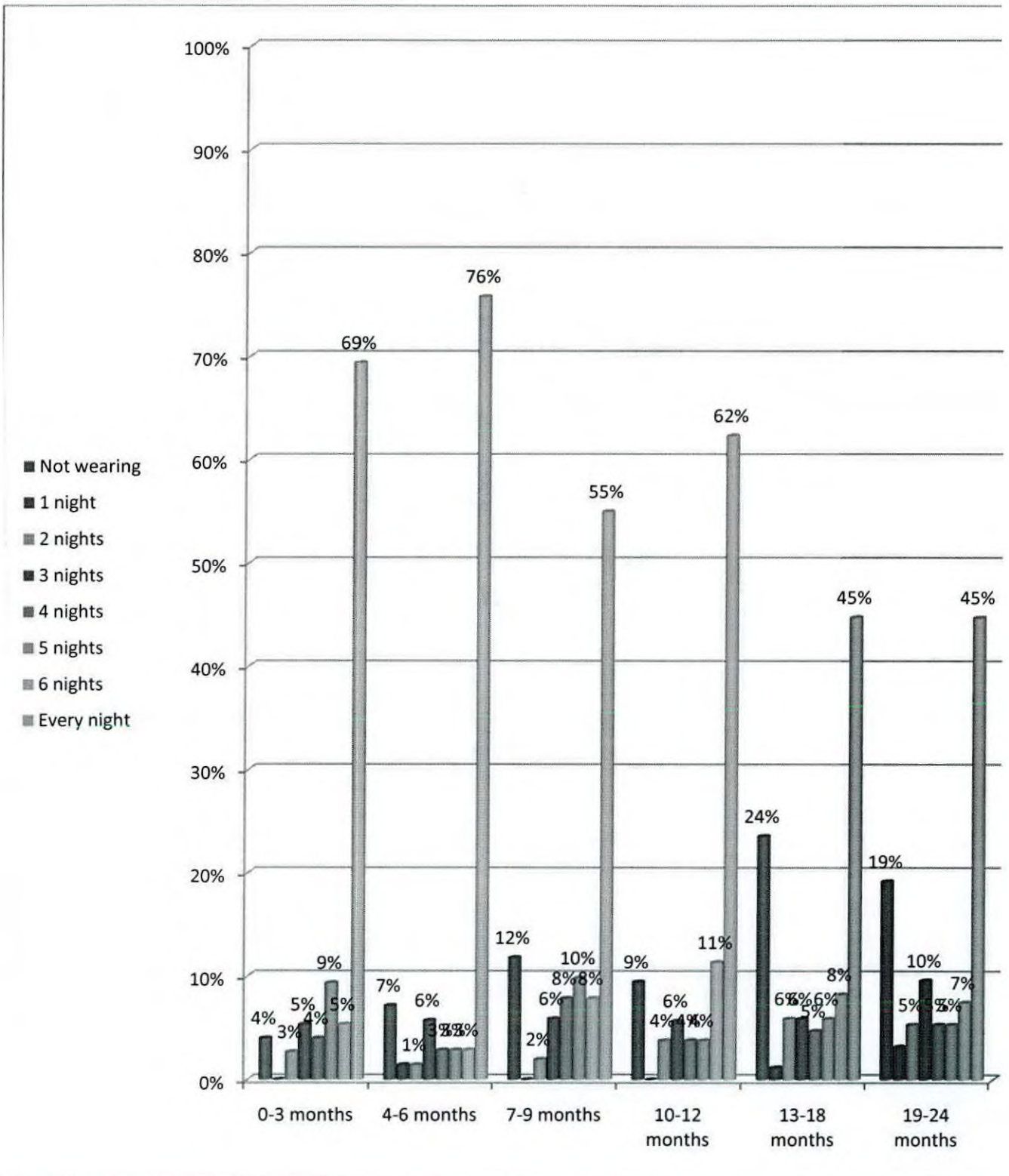


Figure 26: Nights per week patients are wearing their retainers by age

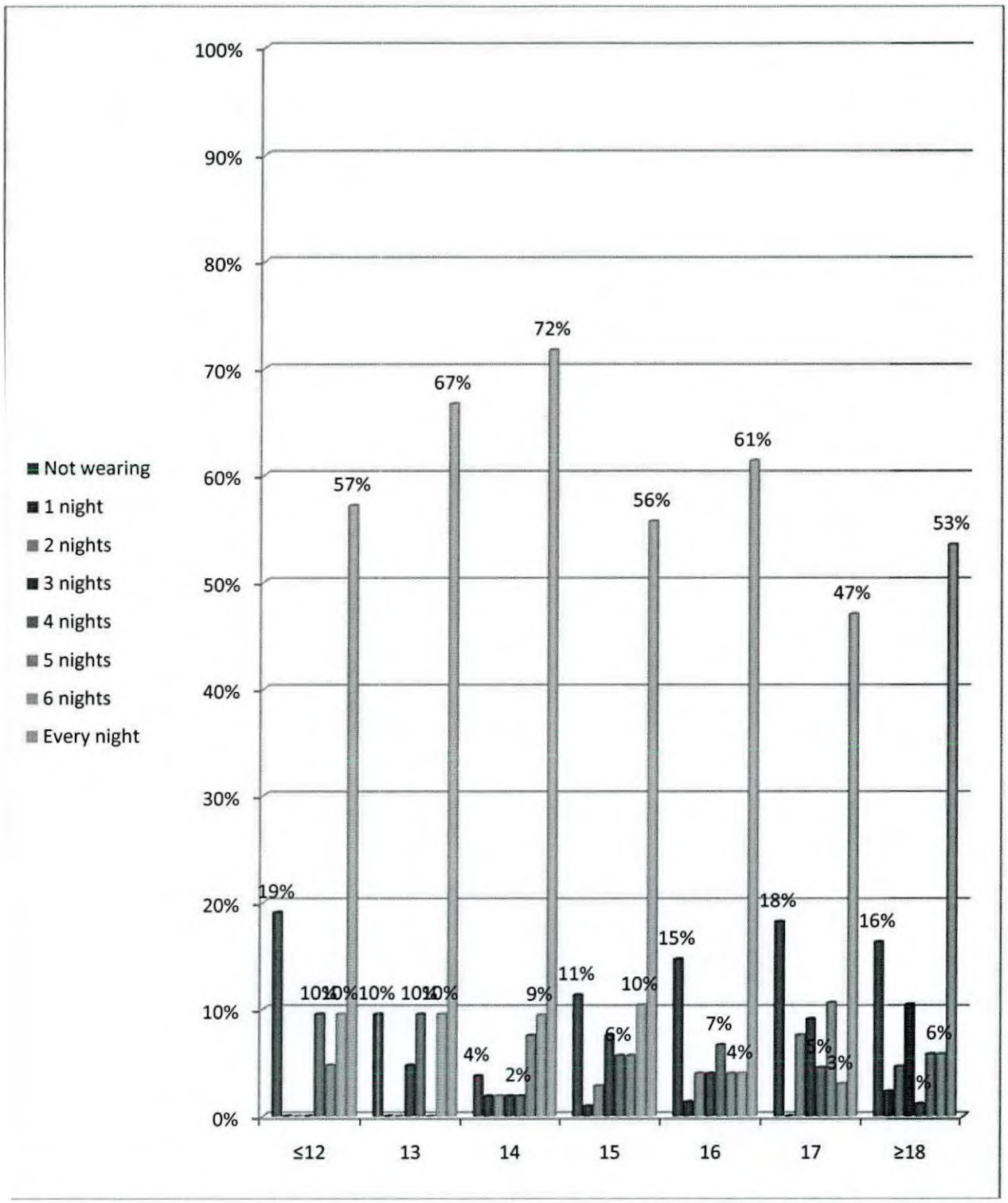


Figure 27: Nights per week patients are wearing their retainers by gender

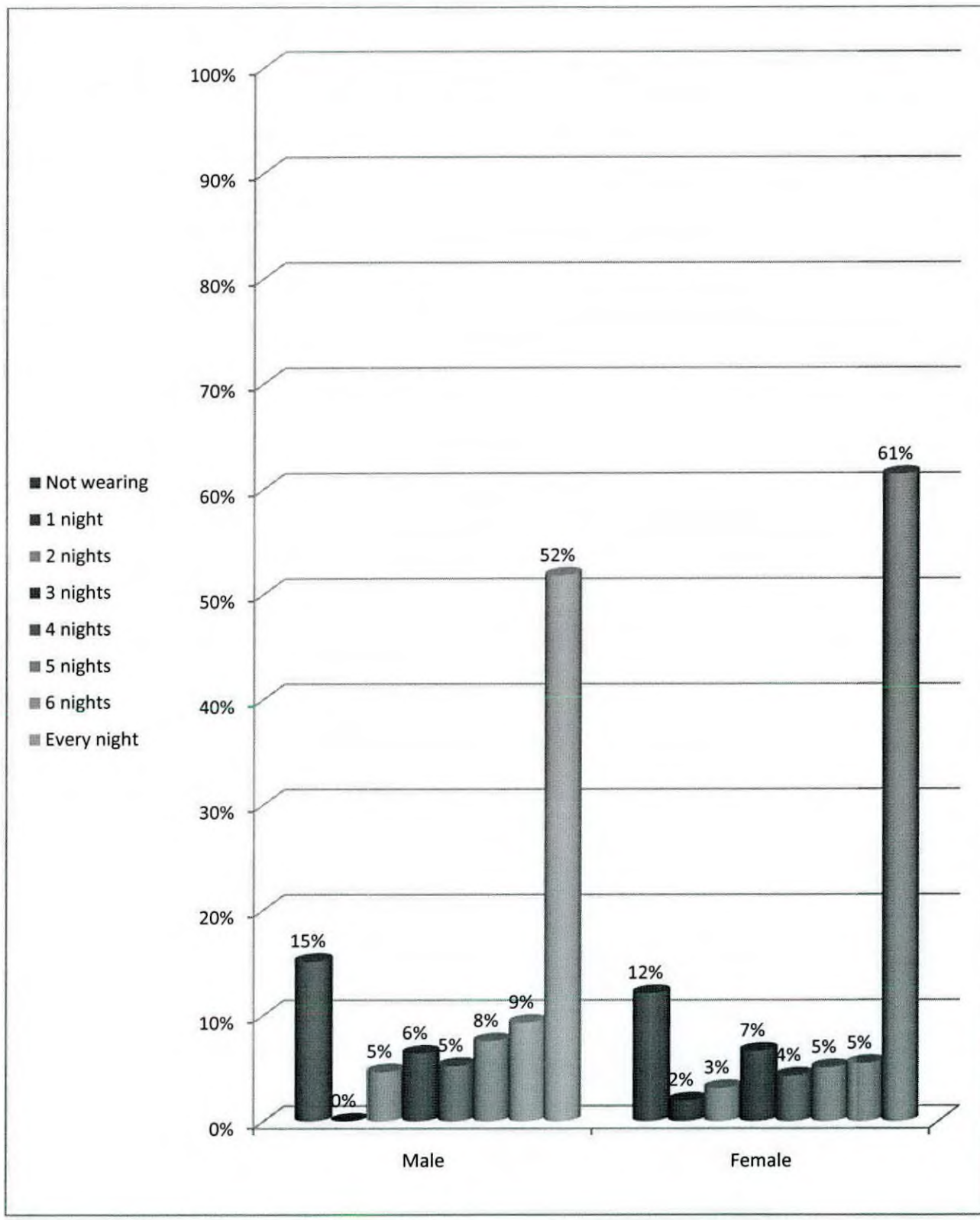


Figure 28: Nights per week patients are wearing their retainers by Maxillary retainer

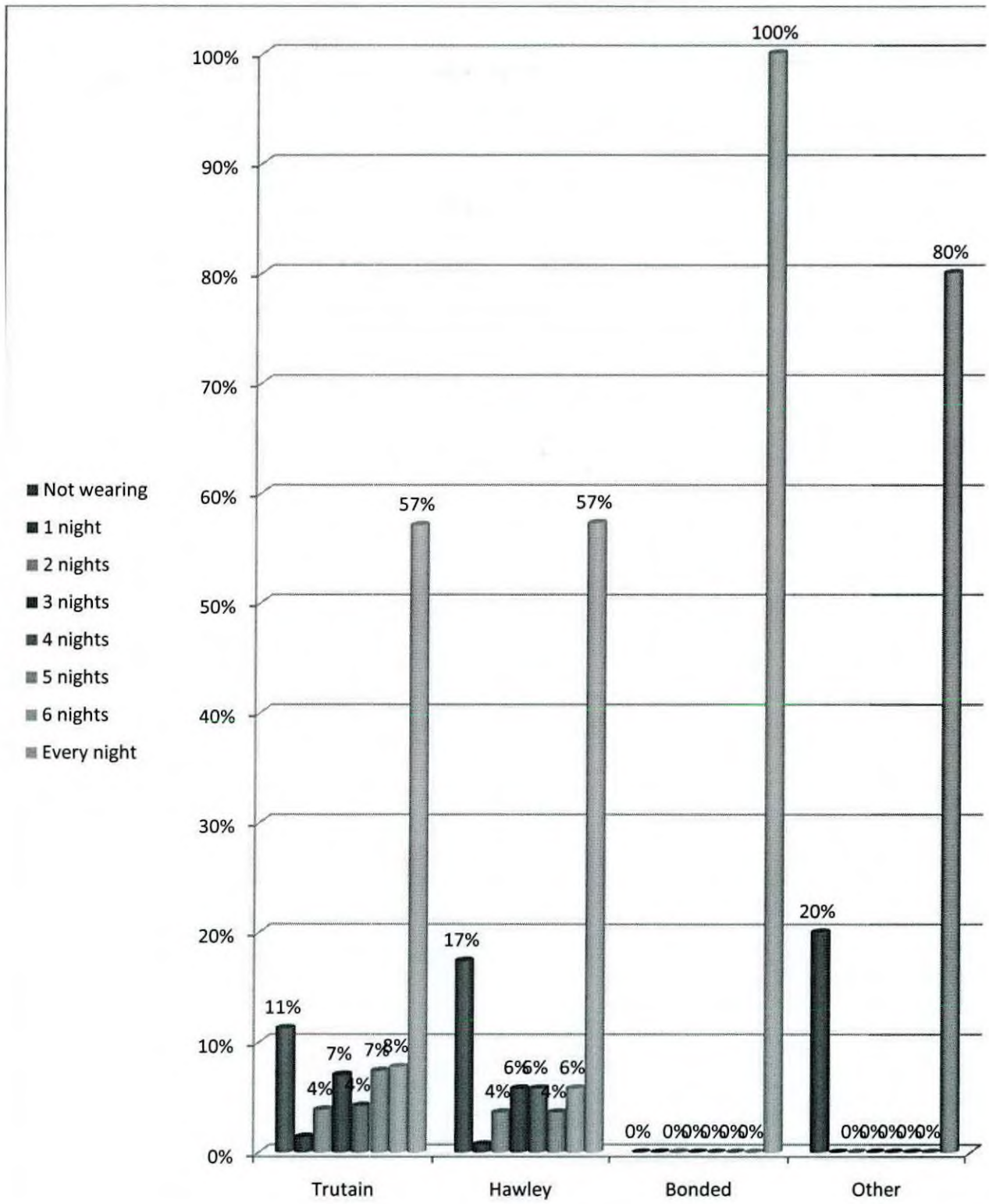
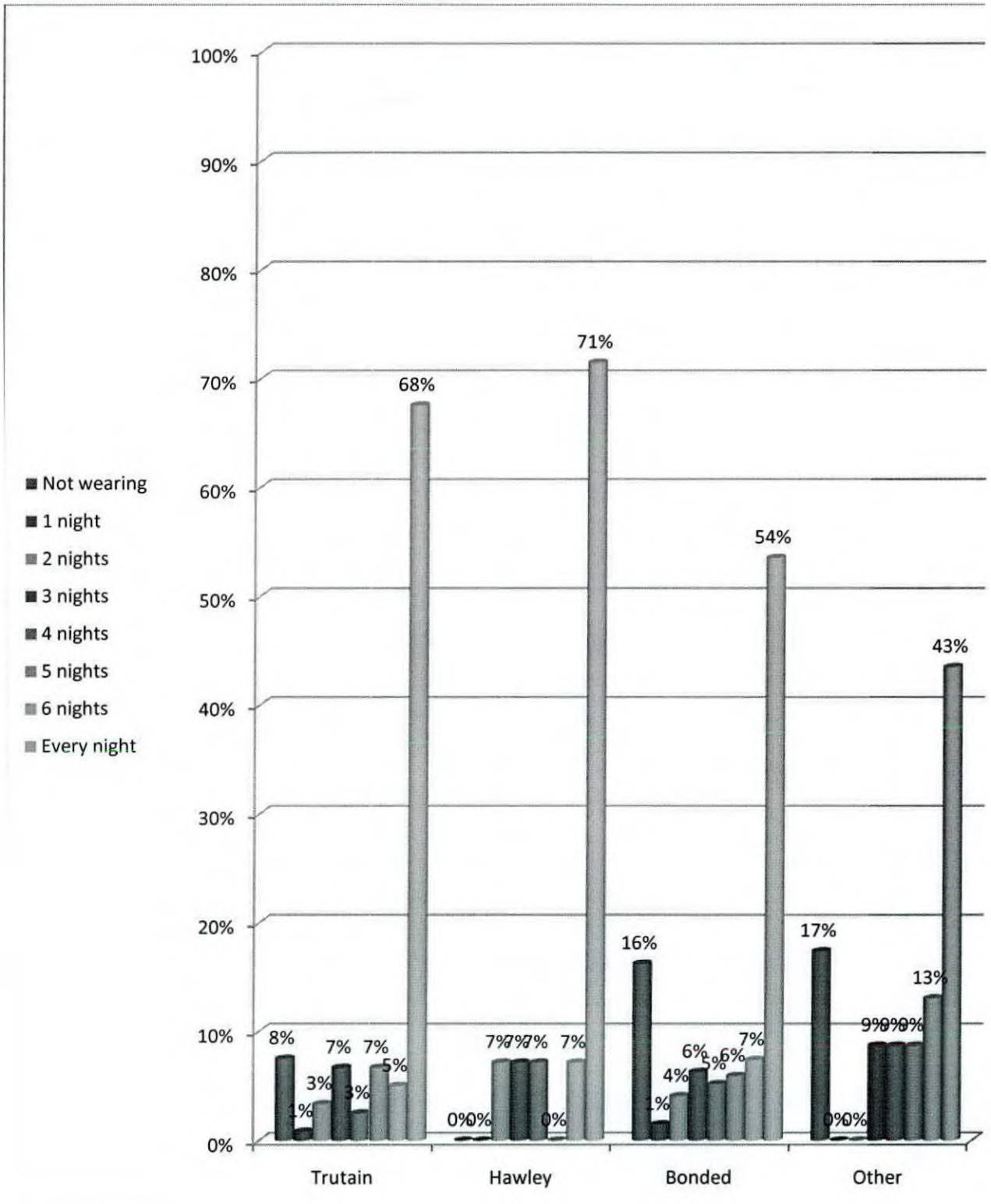


Figure 29: Nights per week patients are wearing their retainers by Mandibular retainer



Institutional Review Board Approval

Case Western Reserve University
Institutional Review Board
NOTICE OF APPROVAL

Responsible Investigator: **Manish Valiathan**
Department: **Dental Orthodontics**
IRB Protocol #: **20080103**
Title: ***Self-Reported Retainer Wear Status***
Co-Investigator: **Kurtis Kacer**

Approval Date: **February 19, 2008**
Continuing Review Deadline: **February 4, 2009**
Expiration Date: **February 18, 2009**

The Institutional Review Board (IRB) has APPROVED the above new protocol through the expedited review process.
It has been determined that this study involves minimal risk, and that the following vulnerable populations will be involved: minors, university population.
As an investigator of human subjects, your responsibilities include the following (see full description of responsibilities at our website).

1. Report all adverse events and unanticipated problems involving human subjects to the IRB Office, located in the Office of Research Compliance (ORC), within three (3) business days of your knowledge of the occurrence.
2. Provide the IRB with a complete Continuing Review form (available at the CWRU IRB Web Pages, or from the ORC) by the continuing review deadline noted above, and when the study is terminated.
3. Discontinue all work pertaining to this protocol if a continuing review approval is not finalized by the expiration date noted above.
4. Submit all proposed changes to the protocol to the IRB, and receive approval from the IRB, before implementation of the change.
5. Keep all research data and original consent documents in your possession for at least three (3) years after the study is terminated.

Please use the attached consent forms for your study.
If you wish to amend it, please submit an addendum – wait for IRB approval – prior to implementation.
If you have to place your consent on letterhead AND/OR online, please make certain you use only the text on the stamped document.

Questions? Please visit our website: http://orc.rs.cwru.edu/orc_humansubjects_CWRU_IRB.asp
OR
contact our administrative office…

Isabel Sanchez, IRB Director
216.368.6993
Maureen Dore-Arshenovitz, IRB Assistant
216.368.6925
Fax: 216.368.3737

CASE Institutional Review Board
Office of Research Compliance
Sears Building 657
Cleveland, OH 44106-7230

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